Supporting the Spectacle: Extending the Scope of the Tangible Interface

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ABSTRACT
The development of tangible interfaces has its roots in artistic explorations of different physical modalities through which digital information might be expressed and represented. We present the findings to emerge from an ethnographic study of an artwork that exploits a tangible interface to create and sustain an engaging public experience and to identify guidelines for the continued extension of the tangible interface to support the spectacle. The artwork reveals that the tangible spectator interface is designed to frame interaction and define distinct interactional trajectories that extend beyond the interface itself to foster engagement, support performance, and satisfy social function.

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Tangible spectator interface, art, ethnography, design guidelines.

ACM Classification Keywords
H 5.3 Group and Organization Interfaces - c*ollaborative computing*

INTRODUCTION
In 1997 Hiroshi Ishii and Brygg Ullmer presented the notion of 'tangible interfaces' to the HCI community with the aim of bridging the gap between cyberspace and the physical environment by coupling digital information with physical objects [Ishii and Ullmer 1997]. The impetus towards tangible interfaces was motivated by the perceived shortcomings of graphical user interfaces and inspired by the emergence and convergence of research trajectories in Ubiquitous Computing and Augmented or Mixed Reality research. There is more to the story, however. The initial development of tangible interfaces was also driven in large

measure by novel artistic works too. Works such as Durrell Bishop's *Marble Answering Machine*, Natalie Jeremijenko's *Live Wire*, and Anthony Dunne and Fiona Raby's *Fields and Thresholds* (ibid.). Artistic explorations of new physical-digital possibilities provided concrete articulations of what 'tangibility' *could* be about, of the different modalities it *could* encompass, and the very different physical ways in which digital information *could* be expressed and represented.

The value of tangible interfaces is now broadly accepted in HCI and they have become an important factor in the exploration and development of human-computer interaction. Today well over 100 articles exploring various aspects of tangibility are to be found in the ACM Digital Library alone, many of them in the CHI literature.[1] The focus here, as one would expect, is highly technical. From specific applications and experience reports to broader critical reflections, general guidelines and design frameworks, technological rationalities inhabit and elaborate the topic of tangibility for HCI.

Can we infer from this that HCI has nothing more to learn from artistic explorations of tangibility then? Does the absence of artistic exploration in the CHI literature mean that the matter is somehow settled and all that is at stake now is to iron out the technological wrinkles? Naturally we are of the opinion that the HCI community may learn more about tangibility from the arts. Artistic exploration has a different character to computational exploration. The orientation to tangibility is alternate but not incongruent. In this respect the design and use of tangible interfaces in artistic settings might raise new possibilities to inform and extend the scope of tangible interfaces and HCI research.

Accordingly we consider the findings to emerge from an ethnographic study [Crabtree 2003] of an artwork called *Day Of The Figurines*. At the heart of the work is a collaborative experience that exploits SMS messaging on mobile phones and an augmented spectator interface situated in a physical gallery to create an engaging artistic event. The spectator interface is a tangible interface. It was expressly designed to create a powerful sense of direct

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[1] For an overview of research in the field see [Hornecker].

physical interaction amongst the distributed participants in an artistic narrative set in a fictional town. Below we consider the design and use of the spectator interface and guidelines that emerge for the extension and future development of tangible interfaces to support the spectacle.

The study confirms recent findings that emphasize the need to move beyond data-centric views that focus on input/output mechanisms and to consider embodied, spatially-centred views [Fernaeus and Tholander 2006] and the design of "methods of facilitation" [Hornecker and Burr 2006]. This will entail developing tangible spectator interfaces to frame interaction through the design of interactional trajectories that extend beyond the interface into the physical environment to foster engagement, support performance, and satisfy *social* function.

DAY OF THE FIGURINES

Day Of The Figurines [2] is a mass participation artwork that spans visual art, installation, performance, and new media work in games. It extends arts-based research of the ways in which new technologies, particularly mobile devices, change how people interact with one another. It is an inversion of previous experiences, where virtual cityscapes have been overlaid onto real ones and connected through mobile devices [Benford et al. 2006, Benford et al. 2006]. Instead, *Day Of The Figurines* creates an imaginary cityscape populated by up to 1000 people who are connected together by mobile phones and SMS messaging.

Day Of The Figurines takes place over 24 days. Each day represents an hour in the life of a fictional town that shifts from the mundane to the cataclysmic. With the passing of each hour a turn is taken. People move towards new locations in the imaginary town; they meet others on their journey; events begin to unfold: pubs open, shops close, the car park gets deserted, Scandinavian metallists play a gig at the Locarno that goes horribly wrong, a gunship of Arabic troops appears on the High Street, an eclipse takes place, there's an explosion, a couple are found dead at the cemetery, and a platoon of soldiers takes over the town. These and other events raise dilemmas for participants, which they must resolve if they are to remain healthy and alive. Alternately participants may undertake missions to maintain their health in a steadily decaying society.

To take part in *Day Of The Figurines* you must physically register yourself. You must go to a gallery where the work is housed for its 24 day duration, you must pay a small fee to enter (which varies according to venue), you must select a figurine, give it an identity, register it online at a public terminal in the gallery, and have an operator check your registration details. The operator gives you a small card with locations and text commands on it, then places your figurine at the edge of a 1:100 scale model of the fictional town.[3] At the same time the system which you have just registered with online sends a welcome message to your mobile phone: e.g., Welcome to Day Of The Figurines. It's 9.30am and the weather is fine. The day has begun for Alfred. Where should he go?

Figure 1. A Participant's Figurine

You send a message back to the system, saying that you want to go to the Locarno or some other place in the fictional town. An arrow is projected onto the scale model. It has your figurine's name on it. The operator moves your figurine to the place where the arrow ends. You and the other people around you watch as the operators move your figurines to their new locations. You approach the table, you put your hands on its polished edges, run you fingers around it, and bend down to take a closer look at the buildings and figurines that populate it. You are supposed to do all these things. The scale model was designed to make you look and touch. It's no accident that it's there. It's an intentional spectacle, a tangible spectator interface, designed by the experience's authors (Blast Theory) to engage you and capture your imagination.
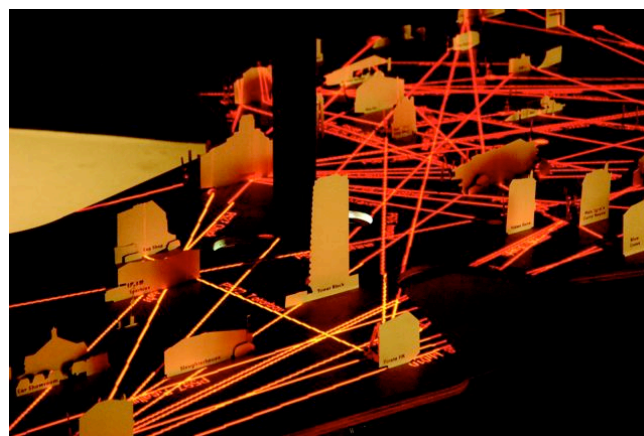

Figure 2. The Tangible Spectator Interface

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[2] www.blasttheory.co.uk/bt/work_day_of_figurines.html

[3] For locations and text commands see:
www.dayofthefigurines.co.uk/

Spectator Interfaces in HCI

Spectator interfaces are an emerging theme in HCI. The development of new interface technologies, embedded sensors, and mobile devices, tied to the increasing importance of interactive technologies in the fields of education, culture and entertainment, is leading to the increasing development of spectator interfaces in public settings, such as museums, galleries, exhibitions, etc. In turn, this has led to a growing interest in spectator interfaces within the CHI community [e.g., Ballagas et al. 2005, Reeves et al. 2005, Benford et al. 2006]. While designing spectator and audience interfaces is a familiar aspect of artistic practice it is still relatively new field in HCI, however.

Nevertheless, even the limited experience of CHI researchers in this area already makes it clear that there are distinctive and challenging issues to be considered here, not least understanding what the design and use of spectator interfaces consists of and demands for their efficacy. As we cannot consult HCI design practice – as none is established as yet – we turn instead to consider the work of the artists involved in the development of the spectator interface for *Day Of The Figurines*. The development of this spectator interface provides us with a 'perspicuous setting' [Garfinkel 2001] where we might observe something of the work, skills, and craft sensibilities involved in the design of spectator interfaces. This is not to suggest that 'studies of work' [Garfinkel 1986] in a particular setting will exhaust the topic in anyway. Only that the CHI community may learn more of the challenges involved in developing spectator interfaces and in extending the scope of tangible interfaces to support the spectacle.

Studying the Design and Use of the Spectator Interface

A diverse amount of data was gathered in studying *Day Of The Figurines* ranging from questionnaires to comprehensive systems logs to ethnographic studies. Different methods were employed for different purposes. Questionnaires were employed to elicit the player experience. System logs to unpack SMS gameplay. Ethnography to understand what happens in the gallery around the spectator interface. We concern ourselves with ethnography here then.[4] We paid several site visits to the various venues where the work was deployed (10 visits between 5 of us at various stages over each deployment to document action prior to, at the start of, during and at the end of the game). We made several hours of video recordings and conducted informal unstructured interviews with participants, operators, and authors whenever we could about events happening on site, which we also videoed (we collected some 20 hours video in total).

In conducting a qualitative investigation we were naturally less concerned with numbers and quantities as we were with quality. We suspended the use of theories to preserve

the endogenous character of the data and similarly abandoned codification of the material as a means of analyzing it [Garfinkel 2001]. Instead, we sought to describe the events we had recorded in order to tease out their 'naturally accountable' features [Garfinkel 1967]. That is, the things that participants, operators and authors busied themselves with, talked to one another about, and were otherwise visibly and interactionally occupied by. We present the results of the study in two separate sections below, one concentrating on the work involved in designing the spectator interface, the other on the work involved in using it.

DESIGN OF THE SPECTATOR INTERFACE

Technically the *Day Of The Figurines* spectator interface consists of the scale model - often referred to as the "game board" - and a projector located below the game board. The projector shines digital arrows onto the game board's surface through a hole in the middle of it and a mirror mounted above it. Functionally, the augmentation quite literally 'points out' where operators are to move figurines from and to. Technically, the design of the spectator interface is relatively simple but then this is not what we mean by 'design of the spectator interface'; or rather, there is a great deal more to its design than its technical composition; more which is salient to understanding the challenges of designing spectator interfaces and of extending the scope of tangible interfaces to support the spectacle.

Envisioning the Spectator Interface

By invoking the notion of 'envisioning' we refer to the artistic motivations and intent that shaped the construction of the spectator interface. This takes us beyond considerations of *Day Of The Figurines* as an artistic exploration to consider the specific motivations that shaped the actual design of the game board itself. We are not talking here of what the experience is then – e.g., an exploration of mobile communication that spans visual art, installation, performance, and new media work in games – but how its design is actually conceived of such that it might address such themes.

The first thing we note is that the experience is essentially an imaginary one. The town where the action takes place is purely fictional. That fiction only exists as textual fragments received via SMS on a mobile phone interface, which as the authors put it is the "most hostile environment you can go to. No picture. No sound. No font even. So the challenge is, can we create a world that will still be meaningful, and resonant, and immersive while using this very narrow information channel?"

The spectator interface is an artistic solution to 1) the fictional character of the experience and 2) the severe limitations of the mobile phone interface. It serves to make an invisible fictional place visible and available to direct experience by giving it a tangible existence. As the authors

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[4] For other findings see: www.iperg.org/

describe the spectator interface, "you have a god's eye view of a town and all the people in it and where they are and where they're moving and you can see who's talking to who. So you're given this tremendous omniscience as a starting point and the idea is that gives you a powerful sort of visceral relationship to the work and to the town that makes you think, I'm going to have a go at this."

The visibility, the tangibility, of the spectator interface is explicitly designed to *frame* participants experience at the outset (something which has recently been recognized as critical to design in this area by HCI researchers [Benford et al. 2006]). Registration could be done entirely online, no one ever need step foot in a gallery, but that would undermine the artistic endeavour. The whole point is that participants come to see the work and that in seeing the work their experience is framed from the outset by the artists. The spectator interface is a key theatrical *device* for achieving this and the experience is framed in fine detail through careful attention to the built details of the spectator interface.

Building the Spectator Interface

It is one thing to envision the construction of a tangible spectator interface, another to realize it. When we look at the work involved in building the interface a number of concerns come to the fore that are distinctive to the artistic enterprise and which have real salience to the further development of tangible interfaces in HCI. In the first instance the artists are occupied with creating something that is unique. Not necessarily something that is one of a kind – even painters create multiple versions on a theme (consider Picasso's Blue Period, for example) – but something that catches the eye at-a-glance. As the authors put it, "it's clearly about interest, about making something that invites you to consider and look at it."
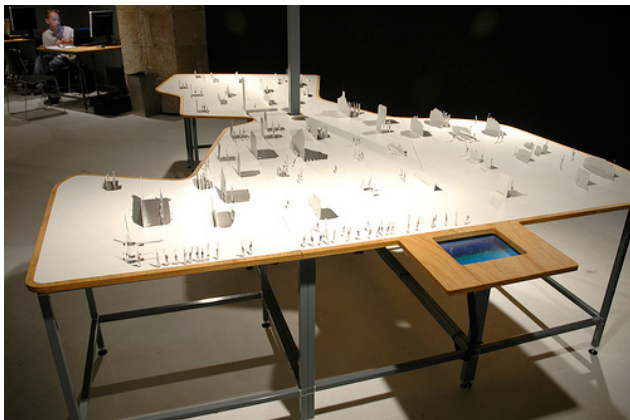

Figure 3. The Spectator Interface

Creating something that 'invites you to look at it' involves a certain attention to detail that does not normally occupy the design of tangible interfaces in HCI. First there is the shape of the board itself. It is not square or some other uniform shape but intentionally irregular. The irregularity attracts interest, invites you to consider what it is, and to take a

closer look. Its surface is not white by accident or lack of imagination either but is intended, as the authors put it, "to highlight the figurines very dramatically". Then there are the buildings to consider. They too are carefully designed to attract the spectator's attention:

"So the idea is that the detail in the table, in the buildings, is enough to give people a powerful sense of what kind of building it is. So some of them have very intricate detail. The traffic island, for example, you've got the exact shape of the traffic sign, or the gasometer. We've gone through this very elaborate process for the cutting so that it's a very defined thing and it invites your gaze. Others are more abstract. Like Trafalgar Square, it's a more simple silhouette. Nevertheless, there should still be enough detail here to pull people in and make them feel that they can imagine what they're looking at."

Figure 4. Inviting the Spectator's Gaze.

The buildings are also very carefully arranged so that shadows fall in the same direction to clearly define the front and back to the interface. This is echoed in the irregular design of the game board itself, which has an "opening point" at the front (on the left of Figure 3) and allows spectators to physically immerse themselves in the interface and get up close to the buildings and figurines that populate it. The physical definition of front and back is not intended to confine the spectator to the front of the interface, but to create different perspectives on it. To create "a privileged sense of going around the back" and of seeing "figurines inside the buildings, inside the silhouettes, inside the shadows". The irregular design of the game board and arrangement of buildings to display front and back articulates different points of engagement with the spectator interface then.

The height of the interface is important too. While the design of the buildings and placement of figurines invite spectators gaze, the spectator is obliged to crouch down or squat on haunches to get a closer look. The height of the table "encourages" the spectator to take a closer look and see the interface from yet another perspective that immerses them more deeply in the fictional town. There are boundaries however, and the edge of the interface which is

clearly delineated by a wooden beading not only circumscribes the interface but also demarcates the boundary between the gallery space and the artwork. The boundary delineates the spectacle and focuses the spectators' gaze. While they might touch and indeed are expected to come up to the boundary and touch it, the invitation extends no further.

The final built element of the spectacle is the augmentation of the game board. Digital arrows with figurine names displayed alongside them mark out the route where figurines are to be moved from and to. Careful attention has been paid to the aesthetics of the augmentation: to the shape of the arrows, the colour, the font. The augmentation is about more than functionality, more than merely showing where figurines should be moved, and aims to create "a visceral emotional response" to the fiction as well. The augmentation gives it a life, a visible dynamic, which is intended to engage not only the spectators' gaze but their attention as well. That attention is further sustained by a small computer display embedded in the end of the spectator interface that shows all the SMS messages coming into the game. Thus, the augmentation creates and articulates a very tangible connection between the distributed participants who are involved in an utterly fictional experience.
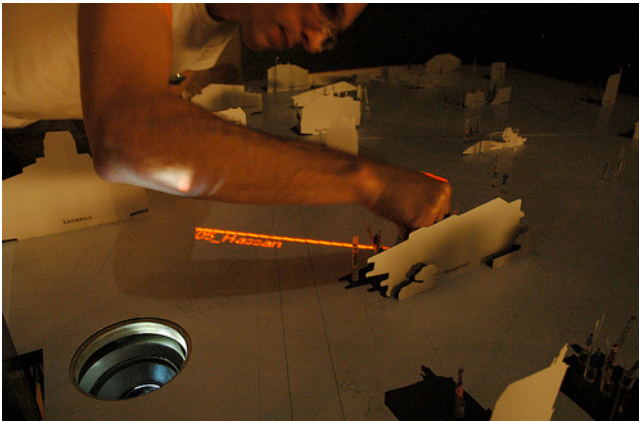

Figure 5. Augmenting the Spectator Interface

When we look at the work involved in constructing a framing device – i.e., the spectator interface – we see that aesthetics plays an exceptionally important role. We would suggest, however, that it is not aesthetics itself that HCI should concern itself with when considering the scope of tangible spectator interfaces, but what aesthetics do, what they accomplish, how they work. Thus, and this case, we can see that the aesthetics of design are oriented towards catching the spectator's eye and inviting a closer look through the design of the shape of the interface; using colour, intricate shapes, light and shade to dramatize the interface and draw the spectator's gaze; carefully arranging physical elements on the interface and of the interface to create perspective and delineate boundaries; augmenting the interface with digital effects to grab the spectators attention and create a tangible sense of interaction.

What this careful attention to detail achieves is not just a powerful aesthetic effect. More importantly it provides a tangible *interactional framing* of the experience. In other words, what we have here is not just something that looks good but something that in the various built details of its looks actively frames and directs the spectator's interaction with the interface. In the various details of its construction it invites their interest at-a-glance, invites them to look closer, invites their gaze, invites them to crouch down and take a close look, invites them to adopt different perspectives, invites them to witness the dynamics of the experience as it unfolds. These are not just words. They index actions. In the fine-grained details of its construction the spectator interface projects a distinct *trajectory of interactions* which range from first seeing the interface at a distance to having your hands on it and becoming immersed in the experience.

Situating the Spectator Interface
Framing the trajectory of interactions with the spectator interface also occupies the work of situating it in physical space. The interface is not simply installed in a venue. The installation takes work. In addition to practical concerns revolving around whether or not the installation space is big enough, and the practicalities of getting the interface on site, the work of installation is occupied by some rather distinctive concerns that impact directly on the spectators trajectory of interactions towards and with the interface.

The first of these concerns the positioning of the spectator interface. Like any artwork or even more mundane objects, it cannot just be placed anywhere. As noted above, the interface has a clear front and a back. That is not something that is just a property of interface itself but of its position within space. Thus, the interface has to be situated in physical space such that it can display its orientation. This is contingent on the layout of the space. Particularly where the entrance is located as the front and back of the interface are relative to these. The layout of physical space may affect positioning in other ways. Positioning of the interface at one venue was affected by health and safety regulations, which meant that it could not be placed within 1.6 metres of a fire exit. The interface had to turned from the preferred position, though the relationship between the entrance and the table still afforded a trajectory to its front.

Positioning the table in just the right place, in just the right relationship to the spectators' entrance to the space, is incredibly important. As an artwork in a gallery the spectator interface is not alone. Other things are going on throughout the building, things that may well vie for the spectators attention. The relationship between the work's position and the entrance to the space defines the moment of first encounter and everything may turn upon it. As the authors described the relationship: "We know in this space that every single person that comes in will see it from that door first. That's the point at which you've got to give them

that thing of like 'Wow! What is that?" You know, pull them right down the room."

Getting that relationship right takes work. The interface has to be positioned within the constraints of the space. It has to have a direct relationship to entrances. And it has also to be positioned with respect to the flow of people through the space. Thus, and for example, in the same space with the 1.6 metre positioning constraint, there was a walkway to the public toilets down which many people could be expected to travel. The spectator interface was positioned in relation to the expected flow of people through the space then. Ultimately, positioning the interface was and is a matter of balancing its position in space. Of balancing the relationship between physical constraints, entrances, and the flow of people through the space.

There is also a need got to create that all important "Wow!" factor and a great deal of effort goes into arresting the potential spectator's attention. Again one cannot just shine a spotlight on the interface and again this is a matter of balancing several concerns. In the first instance a great deal of effort goes into determining the correct colour and level of lighting and this has to be done in each venue as colour and light levels change from place to place. So different gels are experimented with until just the right effect is obtained. What constitutes 'just the right effect' is a balance between the colours chosen, the light level, the position of the lights, and the effect these all have on the spectator interface up close and at a distance.

The position of the lights impacts upon the degree of shadow that is cast on the interface and how "clean" the shadow of the text cut in the buildings is. Too high or too low and you "lose" the cleanness of the text. The colour might be too "cold", "dominate" the augmentation, "spill" over and around the interface onto the ground, or exhibit unpalatable "differences" when viewed from different parts of the room. Gels have to be mixed, levels changed, different physical perspectives adopted all with the aim "that as you come in the door you've got the maximum impact. What you want is the entire surface of the board pulsing with light. Of course, it's completely unrealistic because you have the augmentation and the level needs to right when you are actually at the table. So we're looking to try to find a balance of as much power as we can and as much pulling everyone's gaze towards the table as we're able without wiping out the augmentation and making it completely dazzling for people when they're around the table."

The work involved in situating the spectator interface is not incidental to interaction. It frames it. It shapes the spectator experience, extending the interactional trajectory beyond the interface itself to reach out into the physical space and attract the spectator's gaze from afar. The lighting of the interface to 'pull the gaze' and its positioning to enable the ready access and flow of people shapes the spectator's journey, leading them from passing doorways and walkways to the boundary of an imaginary experience whose dynamics unfold in very tangible ways before their very eyes. Situating the interface is key part of designing for the spectator's interaction with it then. [5]

Summary of Key Design Issues

- The tangible spectator interface is not simply a functional input (or output) device but a *framing device* that shapes the spectator experience.

- The tangible spectator interface is designed not only with respect to its input (or output) functionality but is constructed in varying degrees of detail to articulate a distinct *interactional trajectory* for the spectator.

- The design of the interactional trajectory extends beyond the spectator interface to the *physical space* in which it is situated and the positioning of the interface in relation to building constraints, access, flow of people, and lighting.

USE OF THE SPECTATOR INTERFACE
The design of the spectator interface in *Day Of The Figurines* is very much akin to the 'plan in the machine' [Suchman 1987]. It speaks of intended use. But what of actual use? What does that consist of? Does it resonate with the authors' motivations and intentions? Below we consider the work that went on around the spectator interface in the course of the experience.

Fostering Engagement
TO DO – need more data from Birmingham

'noticeability' – social organization of interaction - visitors are intimately sensitive to the actions of others in the space – visitors often approach, explore and appreciate exhibits with intimate regard to the actions of others within perceptual range of the piece [vom Lehn].

provides an occasion for interaction and discussion

Many interactive artworks and exhibits fail to engage people in collaborative exploration and activity.

provides ample opportunity not only for a brief exchange, but occasions and opportunities for a sustained collaborative exploration and the creation of aesthetic experience.

Our interest in interaction and co-participation demands a radical re-consideration of the concept of 'interactivity' that ordinarily pervades the design of interactive exhibits for museums and galleries. The majority of interactive exhibits on display in museums and galleries embody a rather meagre concept of interactivity. Interactivity for most in the museum world concerns an individual's participation in,

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[5] It is worth noting that the same concerns or design sensibilities occupy the placement of a small table on where the figurines are located and which is situated nearby the spectator interface.

and engagement with, the exhibit. Interaction *between* visitors is less of a concern, if a concern at all. When designers do consider the participation of 'others', they are often treated as passive observers

Visibly Doing Performance
TO DO - need more data from Birmingham

Orchestration as doing art – usual show and breakdown

The Social Function of Performance
TO DO - need more data from Birmingham

Created a strong sense of place among participants (user perceptions from iPerg deliverable)

Summary of Key Use Issues
TO DO

EXTENDING THE TANGIBLE INTERFACE
Day Of The Figurines may be construed of as an exercise that extends the scope of the tangible interface to support spectator experiences. In this respect it takes us beyond existing concerns with the design of the spectator interface, which articulate strategies for manipulating digital effects and where the focus essentially remains on the functionality of input/output devices [Reeves et al. 2005]. It also extends current HCI research on framing public experiences [Benford et al. 2006] by uncovering some organizing features of the phenomena in the work of professionals.

In studying a particular tangible spectator interface we are not suggesting that the contingent details of its design (the particular shape of the interface, the particular colour, the particular way it's lit, etc.) are of general relevance. We are suggesting that the design of tangible spectator interfaces as *framing devices* that project distinct *interactional trajectories* which extend *beyond the interface* itself to foster engagement, support performance, and satisfy social function is of general relevance.

The design of tangible spectator interfaces as framing devices extends the scope of the tangible interface from a physical input/output device to a spatially situated device that promotes social or collaborative interaction. The ramifications of this are perhaps more pronounced if we consider the work of other HCI researchers in the field. Fernaeus and Tholander [2006], for example, have had occasion to note that HCI should be wary of treating tangible interfaces as mere "input/output channels that can be analyzed and understood on their own." Rather, tangible interfaces "must be understood as having deeper social and personal purposes in the shared, *collaborative space of physical and bodily sense-making activity* that users engage in."

Fernaeus and Tholander move the tangible interface away from data-centric views and locate it in situated collaborative activity, a view which is further expounded by Hornecker and Buur [2006], who extend the scope of the

tangible interface from the coupling of digital data with physical artefacts to recognize that interaction is 1) embodied, 2) situated in physical space and that 3) the design of tangible interfaces is necessarily bound by these factors. Hornecker and Buur suggest that embodiment might be factored into design through the development of "methods of facilitation" that "structure" or "constrain" interaction. The notion of constraint refers in particular to the "set-up or configuration of space and objects". Embodied constraints include such things as the size, form, and location of tangible objects. Such constraints "ease some activities and limit others, determining the trajectories of action or providing implicit suggestions". Such methods of facilitation are closely coupled, indeed intertwined with, the "spatial mapping" of tangible objects and interaction: their distribution, placement, visibility and availability to interaction and performative function within some determinate physical place [Hornecker and Buur 2006].

The contemporary concerns of HCI researchers with embodiment and spatiality suggests that realizing the ambitions of tangible computing to "take advantage of natural physical affordances to achieve a heightened legibility and seamlessness of interaction between people and information" [Ishii and Ullmer] requires a great deal more than embedding computation in physical artefacts. Tangible interfaces and objects more generally also need to be explicitly designed as artefacts-in-collaborative-space and as artefacts-visibly-affording-embodied-interaction. This takes design beyond a concern with the construction of novel input/output devices to also consider the development of methods of facilitation.

The suggestion we make is that study of the work involved in the design and use of the tangible spectator interface in *Day Of The Figurines* reveals something more of what we as a community could be talking about when "methods of facilitation" are invoked:

1. **The design of framing devices.** The design of the tangible interface is shaped not only by concerns with its technological functionality but also by concerns with the ways in which it shapes and affords user engagement with the experience.

2. **The design of distinct interactional trajectories**. Engagement is shaped through the design of the tangible interface such that its components articulate interactional possibilities. The shape of the interface, its height, the layout of objects upon, etc., define distinct interactional affordances and a trajectory of interactions that guide the user into the experience.

3. **The design of interactional trajectories that guide the user through physical space.** The design of interactional trajectories extends beyond the tangible interface into the physical space where it is situated. The location, position, access to it, flow of people around it, the way it is lit, etc., all articulate a trajectory of interactions that guide the user into the experience.

4. **The design of interactional trajectories that foster collaboration.** The effective design of interactional trajectories not only guides users through the space and into the experience but also affords the 'notice-ability' of users themselves. Effective interactional trajectories thereby enable users to attract one another's attention and to both invite and guide potential users into the experience.

5. **The design of tangible interfaces that support performance.** The design of effective interactional trajectories guides users to the heart of the spectacle – a performance of some kind. Whether the performance is of an esoteric nature or more mundane, functionality is essentially subordinate to it.

6. **The design of tangible interfaces that support the social function of performance.** The subordination of functionality to performance is not accidental. It enables distinct social functions to be achieved: the telling of stories, immersion and participation in events, the creation of a sense of place, etc. It is essential then that design make tangible function answerable to social function.

These reflections on what might constitute "methods of facilitation" may be used as guidelines to shape the development of future tangible spectator interfaces. They are reminiscent in effect of previous reflections on the graphical user interface, where design was turned inside out to reflect the organizational character of interaction [Grudin]. The concern with embodiment and spatiality has the same effect. It draws attention away from input/out devices to consider organizing features of interaction: tangible spectator interfaces are situated in physical places and interacted with collaboratively in bodily ways for performative purposes no matter how esoteric or ordinary those performances and purposes may be. The suggestion is then that designers need to support the organizational aspects of tangible interaction too when designing for the spectacle.

CONCLUSION

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