

# Tangible Interaction Design, Space, and Place

Eva Hornecker

Interact Lab, Dept. of Informatics

University of Sussex

Falmer, Brighton BN1

UK

[eva@ehornecker.de](mailto:eva@ehornecker.de)

## INTRODUCTION

Books and lectures on Interaction Design often focus on screen-based, desktop-style systems. Yet with the proliferation of computing and its embedding into a multitude of everyday objects or the environment itself, augmented by new conceptual approaches to human-computer interaction such as mobile, pervasive and ambient computing, this is a limited view. With computing merged into objects and environments, interaction design suddenly shares issues with product design, architecture, performance studies and many other disciplines that deal with the design of future human interaction with objects and with (or within) space.

Having started out with an interest into tangible user interfaces and how these support collaborative use settings, my research interests successively broadened towards tangible interaction (perspectives influenced by product and interaction design) and ubiquitous computing – one might summarize this as “off-the-desktop, non-GUI interaction design”. Many issues and concepts uncovered in my thesis on collaborative use of tangible interfaces (Hornecker 2004a) could I later-on apply fruitfully to systems and interactive environments that at first sight have little in common with tangible interfaces. This suggested opting for a broad view on *tangible interaction*, leaving the somewhat artificial constraints of any definition behind, and applying the acquired concepts to this larger design space (see Hornecker 2004b, 2005). These concepts and issues have been structured and fused into a design framework on tangible interaction for collaborative use. One of these themes is *Spatial Interaction*. Also related to it is the theme of Embodied Facilitation (Hornecker 2005).

Issues of spatiality have been little discussed so far in the literature on tangible interfaces (TUIs). Patten and Ishii (2000) compared the use of spatial distribution for organization and recall of information, finding that people utilized more versatile strategies with a TUI than with a GUI. Sharlin et al (2004) argue that manipulating tangible objects exploits human intuitive spatial skills and conclude that providing good spatial mappings between TUI elements and the task is essential, suggesting inherently spatial domains to lend themselves best to TUIs. Broader views on spatiality that take the social aspects into account have been rare (to some extent: Dourish 2001).

Spatiality is an inherent property of tangible interfaces and is so in a wider sense. Tangible interfaces are embedded in

space, they take up real space, they are situated in places, and users need to move in real space to interact with them. The relationship can be viewed from the other side as well – interaction with spatial installations or interactive spaces (Bongers 2002, Ciolfi 2004) can be interpreted as a form of tangible interaction that is not restricted to touching and moving objects in space, but might include moving ones own body in space.

Within this position paper I will summarize several concepts and themes from the before mentioned framework and sketch how they *could* relate to a current project that I am currently involved in, which is part of the British EPSRC project Equator. This project (Halloran et al 2005) falls into the realm of mobile, pervasive and ambient computing and thus provides a possible case study for this workshop. The ideas presented here are not part of the mainstream of this project, that I am taking opportunistic use of as a realistic background for a thought experiment.

## A SHORT SUMMARY OF THE DESIGN FRAMEWORK

The framework is structured around four interrelated themes, which offer different perspectives. Each theme consists of three or four concepts, which are broken down into concrete guidelines. I will here only explain those themes and concepts relevant for my argument.

### Spatial Interaction Theme

Spatial interaction is relevant to tangible interaction because spatiality is an inherent property (see argumentation given above). Tangible interaction is embedded in real space. We cannot escape spatiality - we are spatial beings; we live and meet each other in space. Because we are spatial beings, our body is the central reference point for perception. Movement and perception are tightly coupled and we interpret spatial qualities (or e.g. the positioning of other objects) in relation to our own body. Spatial relations therefore have psychological meaning and effect our perception of a setting. Real space is always *inhabited* and situated, becoming *place* (Ciolfi 2004, Harrison and Dourish 1996). Real places also have an atmosphere. Another aspect of interaction within space is that spatial interaction is observable and often acquires *performative* aspects (Robertson 1997). These performances take part in shaping an atmosphere and are an essential part of encountering other humans. The fact that interaction or movement within real space is observable and legible is an effect of the properties of real space. Different from most attempts in tele-communication, real

space provides *non-fragmented visibility*, allowing us to see someone pointing while being able to follow the pointing as the two points of interests are seamlessly connected. Interacting in real space furthermore has the potential of employing *full-body interaction*, asking for large and expressive human movement which has meaning in interacting with the system and also is easily observable, acquiring communicative and performative functions.

#### **Embodied Facilitation Theme**

With tangible interaction we act (or move) in physical space and in system space (software). Software defines virtual structure, determining the interaction flow. Physical space prescribes physical structure. Both types of structure allow, direct, and limit behavior, determining usage options and behavior patterns. Thus, they shape the ways we can collaborate; they can induce us to collaborate or make us refrain from it. Tangible interaction systems embody structure. Design can enforce social structure and we can learn from facilitation and pedagogical methods how to do this (for a full account of this theme see Hornecker 2005).

One of the concepts of this theme that we found potentially relevant for our application context is *Embodied Constraints*. This concept is best summarized in the colloquial language question: Does the physical set-up lead users to collaborate by subtly constraining their behavior? Embodied constraints refer to the physical system set-up or configuration of space and objects. They can ease some types of activity and limit what people can (easily) do. Shape and size of interaction spaces can e.g. bring groups together, help them to focus on a shared object, or hinder communication.

#### **Tangible Manipulation Theme - Performative Action**

*Performative Action* relates both to spatial interaction and tangible manipulation. Moving in real space is observable and thus performative. Manipulating tangible objects, because it inevitably takes place in real space, creates performativity. It gains even more performativity, because the size of tangible objects provides visibility to the objects themselves and increases the size of users movements.

#### **UBICOMP VISITING A HISTORIC HOUSE ESTATE**

I am drawing opportunistically on a project that I am currently involved in, utilizing it as an example for my own research purposes. The main project members are John Halloran, Geraldine Fitzpatrick and Eric Harris from the Interact Lab, Cliff Randall from the University of Bristol, Danus Michaelides, Don Cruickshank, Mark Weal and Dave Millard from Southampton University, which leads the project. Details on the project are described in Halloran et al (2005).

As Halloran et al (2005) describe, the aim of the Chawton House project is to develop engaging experiences for visitors to an historic English country estate, which blend into its specific atmosphere. The vision is enabling visitors to explore the estate on their own (carrying a networked, mobile device) while tapping into curators' knowledge about the estate. These experiences are to be co-designed with curators who are eager to tell visitors about the

grounds and to attract further visitors, but lack time to give regular tours of the gardens. The projects long-term aim is a persistent infrastructure for long-term use and adaptation by various groups 'using' the estate. We are currently working on enabling experiences for 'normal' visitors and a school fieldtrip. The estate operates primarily as a centre for the study of early English women's writing, funded by a charitable organization. Where appropriate, the landscape has been returned to its early 19th century design, reflecting the open landscape ideals of this period, an impression hampered by signage and visible technology. The house was built around 1580 by the Knight family and has remained in their property. Besides of being a historic house, the estate differs from a museum by being primarily a study centre. Furthermore the building and grounds themselves are of interest to visitors, and artifacts are part of the space, rather than merely placed within it. The stories that curators tell when touring the grounds are highly interlaced, linking the house and the grounds with each other as well as the various themes that we could identify so far (from architecture, landscape design, the family history, to estate management and gardening).

#### **Envisioned Use Situations and Functionality**

Currently we work with curators to develop a range of tours of the grounds. Visitors may decide on themes they are interested in, follow a given trail or wander about freely. Information 'delivered' will be based on location, stated interests, and visitors' trails through physical and information space. Visitors then experience different locations, e.g. the 'wilderness' – a small (managed) forest with intricate paths and a romantic clearing where 'ladies' could imagine being in a wild place. The devices will provide contextualized audio information and visual information providing added value (e.g. paintings of the estate in the 17<sup>th</sup> century). We feel that is important not to distract visitors from their real surroundings, but to add meaning to it. The devices should accommodate groups and individuals, as museum visits are usually social events. This applies to our context as well, as visits require a certain group size and are often by clubs and special interest groups. Only scholars studying in the house might go out on their own during a break for entertainment or to learn more about the estate. While the initial demonstrator will only 'give tours', we imagine extending the scenario to allow visitor annotations. Adding recording functionality would enable the curators to use the device to add new stories, resulting in further layers of stories. In addition there is interest in enabling visitors with specific domain knowledge (e.g. from literary societies or architecture) or a personal relation to the house to record their stories.

A second avenue addresses a different group of visitors. A primary school near Southampton is interested in using Chawton House for fieldtrips with children for literacy education and creative writing. We are cooperating with these teachers on the design of a first fieldtrip. The rich atmosphere and history of the place is valued as inspiring and providing context. Children will explore the grounds and construct narratives around what they discover. For this

type of experience the functionality of the device will be expanded. Children will be able to save information and to record audio (e.g. their own descriptions of a place). After wandering about in small groups the children when convening together should be able to show each other what they collected and to swap content. After exploring the grounds, the children will reflect on their findings and start creative writing in the house.

#### **RELATING FRAMEWORK GUIDELINES TO THE EXAMPLE PROJECT CONTEXT**

As mentioned before, the framework consists of themes which each consist of a set of concepts. Each concept is broken down into guidelines. This provides three levels of abstraction. The themes offer perspectives and argumentation of an abstract, theoretical level and define broad research issues. Concepts provide analytical tools for describing empirical phenomena and summarizing generic issues. However, concepts are quite abstract and cannot be applied without an understanding of the underlying argumentation. For a design framework, a level of more directly applicable, easily communicable design guidelines is needed. It is important to note that the guidelines given in my framework are not meant as strict rules, but as 'design sensibilities' (Cioffi 2004) that can inform system design.

Pursuing my research interest of exploring the utility of my framework and gaining experience in how to work with it, I asked colleagues (some involved in the project, some with research interests in tangibles) to engage in a small workshop. We experimented with utilizing the framework in a card-game-like fashion (cp. Brandt and Messeter 2004), playing out and negotiating guidelines that we considered relevant. We quickly decided that in order to achieve pace and to keep within the card-game pattern, we needed to concentrate on guidelines only, minimizing explanation of concepts. Each guideline was given on a separate card. For each concept, we spread out guideline cards and discussed which ones we felt to be relevant (to collect in the middle) and which to deviate off. Discussion was lively, inspiring, and controversial, demonstrating that the guidelines could inspire design and fuel discussion. It successfully structured our discussion, ensuring we covered a wide set of issues and settled on those relevant quickly. While structuring discussion and offering issues to think about, they are open to interpretation. As a design game, it was only a first rudimentary trial – we ended up with a large set of guidelines needing further prioritization. A game with more inventive, less simple rules could structure the process towards this end, but that is yet another research issue – here our outcome is primarily relevant.

Applying the framework to this application context has primarily been a thought experiment, as it is not part of the mainstream of the project and of Equator itself, having been developed independently. While I do hope the following ideas to provide long-term inspiration (only time will tell), the project has its own dynamics, with many design decisions already been taken, distributed over partners, and many ideas not be feasible in the projects short time frame.

#### **Interpreting guidelines to the project**

As mentioned, I restrict discussion here to those guidelines that we selected which are relevant to the workshop theme. The themes have been presented earlier: Spatial Interaction, Embodied Facilitation and Performative Action as an aspect of Tangible Manipulation.

##### *Inhabited space – spatial interaction*

###### *Turn space into place*

In the context of the Chawton House project this relates immediately to our aim to build upon and to enhance the atmosphere of the place. The grounds *are* already a place and the challenge is not to interfere with this sense of place and the specific atmosphere that we experienced ourselves when visiting. This is one of the major aims of curators, who invest a lot of time into research into the estates history and want to share their enthusiasm with visitors.

By building layers of stories that visitors may explore we can deepen the meaning of the place. These can include e.g. stories told years ago, stories told by other visitors and former servants and workers for the Knight family, or parts of novels from Jane Austen and her contemporaries taking place in places such as the wilderness or the walled kitchen garden, giving visitors an idea how people at that time perceived and used these kinds of places.

###### *Exploit the Relationship of the human body with space*

This guideline is immediately relevant in a mobile use context. Users' position is a major variable in deciding which information they will be delivered with. Users essentially navigate by walking, as stories will be attached to those locations that they refer to.

The guideline suggests taking this idea to more extremes. The distance to locations could also affect what happens. Devices could notice that people quickly approach a certain location or that they stop in a distance. In the first case they may hear information that encourages them to look back and to enjoy the view, in the second they might hear something that lures them to go on. Audio could get louder if people approach a location, providing navigation clues (in absence of a real person guiding the tour). There may be many more ideas on how to play with location and distance. We can also imagine devices noticing people meeting or devices coming close to each other and engaging in some form of interaction and communication triggered by device actions. Having the schoolchildren congregate, show each other collected content and swap it is one example of what may happen.

##### *Embodied Constraint – embodied facilitation*

###### *Provide a „shared transaction space“*

A shared transaction space refers the interaction space that is given by an interface/system which is bodily shared by a group of users and provides them a shared focus (Kendon 1990). A simple example is surrounding a table, with people building a circle. In this situation one can quite easily observe each others' reactions while at the same time seeing whatever lies on the table as this requires only a quick glance. Facing a wall projection, people can only

form a half circle or a line and cannot see each other well. A transaction space provides exclusive access and limits communication to those sharing it. There is a natural limit to its size determined by visibility and audibility. The portable device can be interpreted as determining a transaction space. A visitor group sharing one device will need to surround it to see or hear the provided information. Thus the size of the device and its display as well as the loudness of audio output affect adequate group size.

*Non-fragmented visibility – spatial interaction*  
*Ensure visibility of objects, actions, effects*

This is an important issue if we remember that the device is meant to support visitor groups. Even if several people have individual devices, visibility of actions is important to allow coordination and awareness or to allow visitors to implicitly communicate through embodied actions. Other visitors should be able to determine what the visitor carrying the device is doing. This is particularly relevant for the recording mode, so that other visitors can design their behaviors accordingly – e.g. wait with comments until after recording or engage on purpose in play-like conversation. Actions like swapping content between schoolchildren could be made legible for observers by using some form of gesture or movement recognition.

*Performative Action – tangible manipulation*  
*Make actions publicly available*

This guideline is related to the former, but points more towards the tangible aspects of interaction. One strategy for making actions easily observable is to require large movements and to have the spots of interactions (in our case probably buttons) visible and accessible for others.

*Allow for the development of bodily rituals*

Some of the bodily interactions with the device (e.g. sharing and swapping content) can be made to feel like a ritual if requiring ritualistic movements, which are e.g. oversized slow or rhythmic. People usually enjoy rituals, as these enhance the meaning of actions with some magic, metaphysic or playful backdrop. Rituals are also highly performative and add memorability to events.

**CONCLUSION**

This position paper discussed space, place and their role for non-GUI, non-desktop interaction design. Elements of a framework supporting design of tangible interaction for collaborative use settings were presented. A current project related to mobile, pervasive media has been used to experiment with relating the framework to concrete design tasks and use situations.

**ACKNOWLEDGMENTS**

This paper does not necessarily represent commitments and methodical approaches of the Chawton House project team. Chawton House project is part of the EPSRC Equator IRC GR/N15986/01. The initial theses work that the framework rests upon has been funded the Hans-Böckler Stiftung and major parts of the framework were shaped while being a guest researcher at the Mads Clausen Institute at the University in Southern Denmark. Thanks to all involved in

the Chawton House project, in particular John Halloran, Eric Harris, Geraldine Fitzpatrick, Mark Weal, Dave Millard, the staff at Chawton House, to all who played the framework game with me: Paul Marshall, Manuela Jungmann, Mark Stringer and Eric Harris, and to Jacob Buur who helped me develop the framework out of my collected experiences and reflections of previous projects and studies.

**REFERENCES**

- Brandt, E., Messeter, J. (2004): Facilitating Collaboration through Design Games. *Proceedings of PDC'04*. pp. 121-131, ACM
- Bongers, B. (2002): Interactivating Spaces. *Proceedings of Symposium on Systems Research in the Arts, Informatics and Cybernetics*.
- Ciolfi, L. (2004): *Situating 'Place' in Interaction Design: Enhancing the User Experience in Interactive Environments*. Ph.D. Thesis, University of Limerick.
- Dourish P. (2001): *Where the Action Is. The Foundations of Embodied Interaction*. MIT Press.
- Halloran, J., Hornecker, E., Fitzpatrick, G., Millard, D., Weal, M. (2005): The Chawton House Experience – Augmenting the Grounds of a Historic Manor House. *Proceedings of international workshop "Re-Thinking Technology in Museums: Towards a new understanding of visitors' experiences in museums"* Limerick (Ireland),
- Harrison, S., Dourish, P. (1996): Re-place-ing space: the roles of place and space in collaborative systems. *Proceedings of CSCW'96*. pp.67-76. ACM
- Hornecker, E. (2005): A Design Theme for Tangible Interaction: Embodied Facilitation. *Proceedings of ECSCW 2005*, in press
- Hornecker, E. (2004b): A Framework for the Design of Tangible Interaction for Collaborative Use. *Proceedings of Danish HCI Research Symposium*, University of Aalborg. HCI Lab Technical Report no 2004/1. pp.57-61
- Hornecker, E. (2004a): *Tangible User Interfaces als kooperationsunterstützendes Medium*. PhD-thesis. University of Bremen. Dept. of Computing, July 2004.
- Kendon, A. (1990): Spatial organization in social encounters: The F-formation system. In Kendon: *Conducting interaction*. Cambridge University Press. pp. 209-237.
- Patten, J. & H. Ishii (2000): A Comparison of Spatial Organization Strategies in Graphical and Tangible User Interfaces. *Proceedings of Designing Augmented Reality Environments (DARE'00)*, pp. 41-50. N.Y.: ACM.
- Robertson T. (1997): Cooperative Work and Lived Cognition. A Taxonomy of Embodied Actions. *Proc. of E-CSCW'97*, pp. 205-220.
- Sharlin, E., Watson, B., Kitamura, Y., Kishino, F., Itoh, Y. (2004): On tangible user interfaces, humans and spatiality. *Personal and Ubiquitous Computing 8(5)*. 338-346.

