

Report “Foundations of Tangible Interaction”

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paper summary

The paper summarized here is called “Getting a Grip on Tangible Interaction: A Framework on Physical Space and Social Interaction by Eva Hornecker & Jacob Buur.

The authors propose a new approach to Tangible Interaction, stating that, until recently, attempts to develop frameworks have concentrated mainly on defining terms or on categorizing and characterizing systems. It is stated that the data-centered model [Ulmer and Ishii] as well as the taxonomy approach both deriving from a HCI background, provide a basis for TI, but give too narrow a view on what is happening:

“While supporting structural analysis, mapping out the design space and detecting uncharted territory, these offer little advice when designing for real world situations and seldom address users’ interaction experience. Despite many interesting explorations of technical options, there is still a need for conceptual frameworks that unpack why ‘tangible interaction’ works so well for users”.

Furthermore, the authors quite baldly state that the “research community lacks concepts for analyzing and understanding social aspects of tangible interaction and design knowledge on how to design for social interaction and collaboration”.

As an alternative, it is proposed to view tangible interaction from a wider perspective, integrating a multi-disciplined array of research. Mentioned are ‘rich interaction’ research in product design, interactive arts and architecture as well as the classical HCI view on tangible interaction.

“We have chosen to use ‘tangible interaction’ as an umbrella term for this field, drawing together several fields of research and disciplinary communities who can profit from each others’ distinct perspectives and knowledge. Tangible Interaction, as we understand it, encompasses a broad range of systems and interfaces relying on embodied interaction, tangible manipulation and physical representation (of data), embeddedness in real space and digitally augmenting physical spaces” [Hornecker et al.]

The framework proposed consists of four ‘themes’ within the field of Tangible Interaction, with in each theme a set of design guidelines (figure 1)

Tangible Manipulation

Haptic Direct Manipulation: Can users grab, feel and move ‘the important elements’?

Lightweight Interaction: Can users proceed in small, experimental steps? Is there rapid feedback during interacting?

Isomorph Effects: How easy is it to understand the relation between actions and their effects? Does the system provide powerful representations that transform the problem?

Spatial Interaction

Inhabited Space: Do people and objects meet? Is it a meaningful place?

Configurable Materials: Does shifting stuff (or your own body) around have meaning? Can we configure the space at all and appropriate it by doing so?

Non-fragmented Visibility: Can everybody see what’s happening and follow the visual references?

Full-Body Interaction: Can you use your whole body?

Performative Action: Can you communicate something through your body movement while doing what you do? digital functions and data, or of other physical objects (tele-control).

Embodied Facilitation

Embodied Constraints: Does the physical set-up lead users to collaborate by subtly constraining their behavior?

Multiple Access Points: Can all users see what is going on and get their hands on the central objects of interest?

Tailored Representation: Does the representation build on users’ experience? Does it connect with their skills and invite them into interaction?

Expressive Representation

Representational significance: Are representations meaningful and of long-lasting importance? Are physical and digital representations of the same strength and salience?

Externalization: Can users think and talk with or through objects, using them as props to act with? Do they give discussions a focus and provide a record of decisions?

Perceived Coupling: Is there a clear link between what you do and what happens? Are physical and digital representations seemingly naturally coupled?

The framework provides a checklist that can be used for inspiration or to evaluate designs using tangible interaction to evoke social interaction; “A conceptual aid that may provide us with a handle for getting to grips with the user experience and social aspects of tangible interaction.”

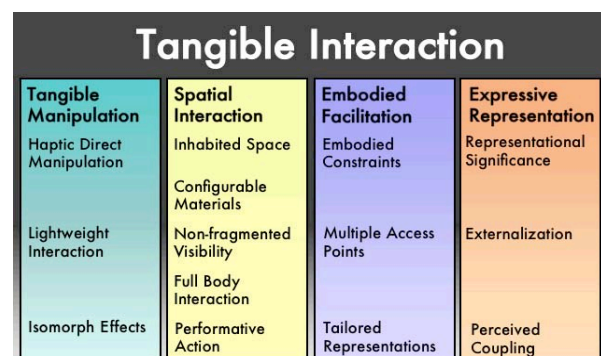


figure 1: TI framework

concept explanation

In accordance to the proposed framework of Hornecker et al, the concept aims at achieving social interaction through tangible interaction. Instead of taking the data-centered (HCI) view or the product design, the concept originates from the viewpoint of user experience and social interaction.

context

When looking at aiming at social interaction through tangible interaction, the importance of context is evident. In finding this context, we looked at places where a) people meet for leisure activities and b) at places that are publicly accessible. We looked at two possible contexts; museum contexts, due to the fact that museums are contexts that provide room for interactive, tangible installations that not necessarily serve a purpose and public square contexts due to the fact that these places can use a lot more interactive, tangible installations that do not necessarily serve a purpose.

What kinds of systems that serve the purpose of entertainment for an audience do we see here? And what kind of systems would benefit from tangible interaction in pursuing social interaction?

The chosen system is a fountain like the Bellagio fountain in Las Vegas (figure 2). The context provides audience in a public space that, in this case are passively entertained by the possibilities of this fountain.

(see <http://www.youtube.com/watch?v=jVV4E110VZ8>).

What if the audience (a part of the audience) gains control over the fountain, providing a possibility to 'direct' a fountainshow (instead of an algorithm that creates a show) via tangible interaction?

In figure 3 shown on the right, the concept is explained;

Installation

The proposed concept is an installation that lets multiple users control the fountain in a playful manner. Users are able to manipulate the fountain in height of beam, color of beam and direction of beam.

The installation consists of a number of lines representing the (equal) number of fountain beams and is positioned (at a reasonable distance) in front of the fountain. Two types of objects represent the different manipulating possibilities. When the objects are put on the lines, the fountain reacts. By sliding the objects up and down along the lines, the height of the corresponding fountain beam can be adjusted; the color of the object determines the color of the fountain beam; shaking the line that represents the beam will cause the same movement in the fountain.



figure 2: bellagio fountain

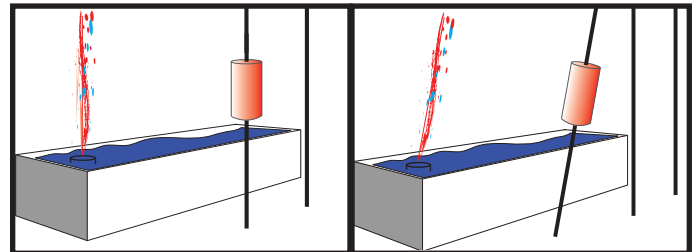
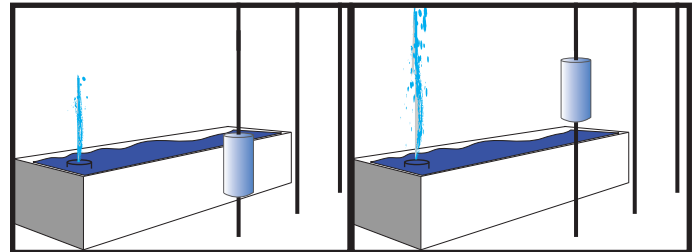
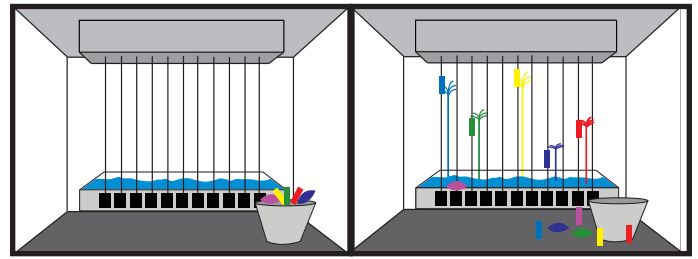


figure 3: installation scenario

Objects

Two types of objects can be used to manipulate the fountain; static and a dynamic. When the static object is put on the line, it remains on the same height. One can slide this object up and down the line in order to manipulate the fountain. When using these objects, one can 'tune' the fountain like a sort of equalizer.

The dynamic object will not remain in the position where it was when put on the line; it will fall down along the line (thus the fountain beam will drop). In order to keep the fountain going, one has to throw the object upwards along the line and/or hold it to a certain position actively. In shaping both objects, the goals was to let the object communicate its possibilities (affordance); the static object being a cylinder-shaped object that invites to grab and slide along the line (figure 4), the dynamic object shaped as ring, the hole in the middle communicating that it will not stock to the line (figure 5).

The augmented scenario of this installation is that a group of people will start manipulating the fountain thus creating a collaborative performance for the rest of audience. By creating both dynamic and static objects, the group directing the fountain-performance is challenged to play with different combinations of possibilities in interaction with the fountain in an active and collaborative way.

concept evaluation through framework paper Hornecker et al.

In the aim to approach tangible interaction as a “way” to social interaction, the framework of Hornecker et al. is used to evaluate this concept on its relevance to collaborative- and social interaction.

First impression

During a first impression of the installation (where unfortunately, the fountain was missing) two observations were made: a) can this type of tangible interaction provoke (any kind of) social interaction and b) can we test this specific design to the ‘design guidelines’. Figures 6 and 7 give an impression on the setting and the results.

Tangible Manipulation

Haptic Direct Manipulation: Can users grab, feel and move ‘the important elements’?

-Yes, the important elements are the objects that manipulate the fountain.

Lightweight Interaction: Can users proceed in small, experimental steps? Is there rapid feedback during interacting?

-Yes the users can proceed in relatively small steps; feedback on the system is immediate.

Isomorph Effects: How easy is it to understand the relation between actions and their effects? Does the system provide powerful representations that transform the problem?

-The relation is very obvious; when I move an objects, the fountain beams moves along with it: when I select a certain color and put in on a line, the fountain directly changes to that specific color.

The representation of the objects towards its actions is probably not powerful enough, because it is not considered thoroughly. Although it is tried to represent actions through the shape of the objects, this was not directly clear to users.

Spatial Interaction

Inhabited Space: Do people and objects meet? Is it a meaningful place?

-People and objects do meet clearly and in that sense in does so in a ‘meaningfull place’; in front of the fountain, creating a direct link to what is done and what can be seen.

Configurable Materials: Does shifting stuff (or your own body) around have meaning? Can we configure the space at all and appropriate it by doing so?

- The key element of the concept is to shift stuff in order to manipulate the fountain; the configuration of objects determines the configuration of the fountain.

Non-fragmented Visibility: Can everybody see what’s happening and follow the visual references?

-In creating a group effort/ performance, all audience, performing and watching can directly see what happens, so yes.



figure 4: static object



figure 5: dynamic object

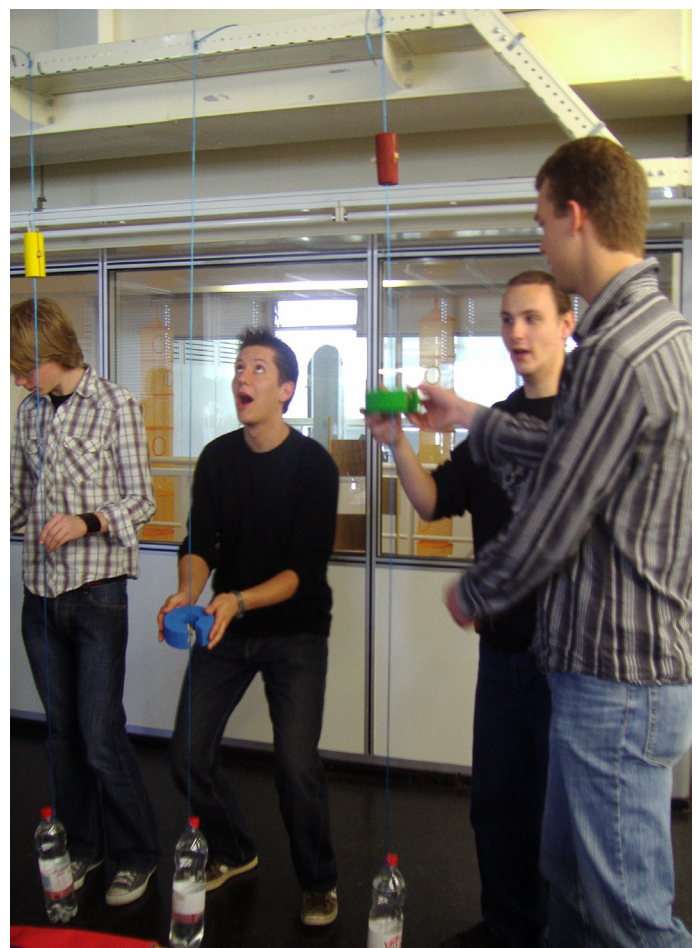


figure 6: spontaneous play

Full-Body Interaction: Can you use your whole body?

-yes

Performative Action: Can you communicate something through your body movement while doing what you do? digital functions and data, or of other physical objects (tele-control).

- When interacting with the installation, playing with the objects directly shows what happens to the fountain, so in this way you are communicating the function of the installation to the fountain

Embodied Facilitation

Embodied Constraints: Does the physical set-up lead users to collaborate by subtly constraining their behavior?

- In a certain way it does, in quite a range (from subtle to rough) The physical set-up, specially the dynamic objects, lead users to collaborate and to 'learn' in what way the fountain reacts to different amplitudes of movement by the objects. The vertical lines in combination with the objects mark the interaction possibilities, corresponding with the vertical fountain beams. Again the shape of the objects could be far more clear in communicating their possibilities.

Multiple Access Points: Can all users see what is going on and get their hands on the central objects of interest?
- Yes they certainly can.

Tailored Representation: Does the representation build on users' experience? Does it connect with their skills and invite them into interaction?

- No it does not build explicitly on user experience. As the short user test showed it does invite interaction.

Expressive Representation

Representational significance: Are representations meaningful and of long-lasting importance? Are physical and digital representations of the same strength and salience?

- this is where the concepts fails in a way; what happens is that physical action is transformed into another physical action through computing (with the discussion point whether this is still tangible interaction?) The objects are coupled to physical changes in the fountain.

Externalization: Can users think and talk with or through objects, using them as props to act with? Do they give discussions a focus and provide a record of decisions? The objects do act as interaction props, maybe provoke a decision (about how to manipulate the fountain).

Perceived Coupling: Is there a clear link between what you do and what happens? Are physical and digital representations seemingly naturally coupled?

- yes, clearly



figure 7: exploring the objects

Discussion

The installation explained above aimed at proposing a way to achieve social, collaborative interaction through tangible interaction, by taking an existing entertainment system in public space and converting it from passive entertainment to active participation; to control. Instead of just watching at the fountain, people can now play with the fountain; tangible interaction is used to design this new possibility as good as possible. The framework used as a guideline in this design process.

Although of course not scientifically tested, during the mock-up short test session, the installation provoked play, and, collaborative play. And I do think that tangible (or is it 'physical'?) interaction is the key factor in provoking this play due to its possibilities in direct manipulation and feedback in this case.

According to the design guidelines we see that the concept does provoke social interaction by tangible interaction. Question remains whether this social interaction is caused by the installation or simply that such an installation works because people (inter) act socially?

What I would like to point out here are some

difficulties I have with this framework, these design guidelines proposed by Hornecker et al.

Although it can prove its worth as a ‘checklist’ when designing (and true, the concept presented does provide an interesting angle in tangible interaction), the framework is not convincingly good at pinpointing how user experience and collaborative interaction can be integrated in a methodology or a design process for tangible interaction. It merely points out that the term “tangible interaction” used in a scientific context can also be projected on a whole array of other disciplines. Which is true, but what is value of this projection for tangible interaction research? Or, as stated by Gillian Crampton-Smith:

“There are thousands of interaction design projects and only a few are really relevant for research” IDIF conference Potsdam.

remarks on tangible interaction

Apparently, the term “tangible interaction” lets itself be explained in lots of different ways, the boundaries of its definition not fully crystallized yet.

When reviewing the design process above, I cannot state that the described approach by Hornecker et al. provides a better “Grip on Tangible Interaction”

In my modest view tangible interfaces are an important step towards a more rewarding relation between the digital and the physical world: rewarding in the sense that physical objects are represented digital and vice versa. Eventually, the most natural way in which these digital and physical objects are to be taking a part in life is when they will have behavior (instead of an interaction model); in that sense that we will attribute human values in interacting with them:

Digital artefacts “behave”. Even if you don’t think about it, it might happen by accident. We don’t need simple interaction design, we need interesting interaction design and that’s the real challenge. Design ambiguous artifacts and let the negotiation take place between the object and the user. Leave space for imagination so that things can happen beyond what can be expected. (Dennis Paul and Patrick Kochlick, ART+COM on IDIF Conference Potsdam)

When looking at the history of TI, taking as a starting point the model Ulmer and Ishii (figure 8) introduced, I do think the shift away from a data-centered view is a relevant one in the field of TI design.

From this very important and useful step towards grasping what is happening between the physical and the digital world, I do believe the research on tangible interaction should introduce a model where users as well as context are at least equally important factors. In that sense the attempt by Hornecker et al. is a step into the direction where we move from menus, command lines and even GUI towards meaningful TI development.

User and context – physical or digital?

In the proposed iteration (figure Y) on the framework of Ulmer and Ishii, the user and the context of the link between digital and physical are taken into account.

However, both user and context still not appointed to a fixed place within this model yet. While proposed that user and context should both be placed within the physical context, I would stress to leave the option open to put the user and the context within the digital realm.

Where tangible interaction used to be focused on manipulation of digital data through physical action, we should consider the full spectrum of the vast potential when (and where) physical and digital space (data) meet. I believe the future of tangible interaction research will expand from this one-way link towards explorations in the link digital to physical. (Tangible interaction within second life; an avatar in the real world to represent my digital identity? Etc.).

Where both entities (physical and digital data/life) have pro’s and con’s, their combination may prove to facilitate the best of both worlds. Not first (physical) or second (digital) life must be the focus of tangible interaction research, but life 1.5.

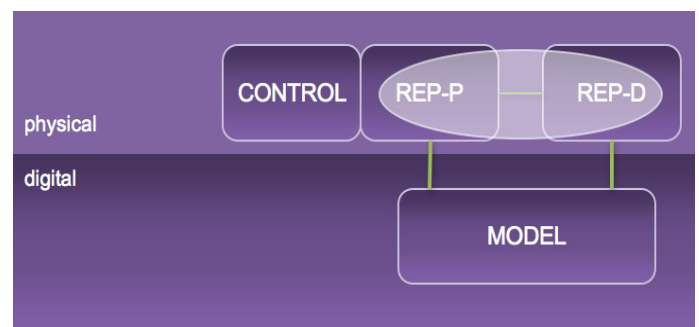


figure 8: Ulmer and Ishii model

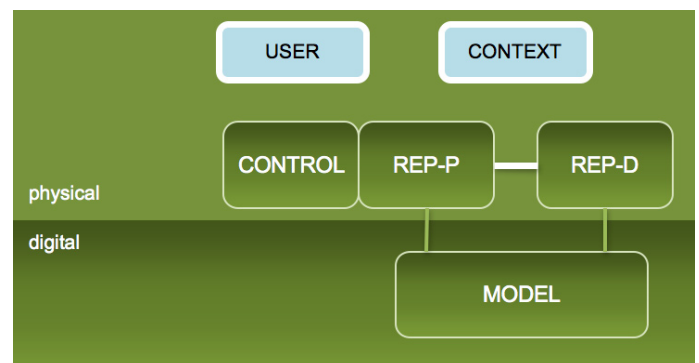


figure 9: iteration on model