Understanding Interaction: going beyond the seamless integration of the digital and the physical

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1. Aims

The main aim of this working document is to provoke discussion on the Equator theme of 'Understanding Interaction' and in so doing move us beyond talking about seamless integration of the physical and the digital and enriching user experiences. This was our starting point when writing the proposal and we should now be in a better position by which to talk about interaction that moves beyond this. In particular, we need tobe able to account explicitly for:

• why we want to make the physical and the digital merge and converge
• what are the outcomes and benefits of doing so
• how are they different from other interactive forms (e.g. desktop applications)
• whether we might want now to change our starting point of 'seamless' and instead consider whether interrupted or discordant juxtapositions of the physical and digital might be more desirable as an end goal for certain kinds of interactions we are interested in.

The ultimate goal is to move our understanding forward and if possible develop conceptual and methodological frameworks that can ground our ongoing research projects better.

2. What is interaction?

Interaction is a very general term that everyone knows but finds it difficult to define – other than in quite prosaic and engineering-based terms (e.g. 'a process of continual action and reaction between two or more parties'). You think it is obvious what it means, but when pushed to explain it becomes much harder to actually express in anything like what you feel you ought to be able to. Like St. Augustine's observation, in the *Confessions*, when no one asks him what time is, he knows, but when someone asks him, he doesn't know anymore.

To get round this impasse, interaction as it occurs in everyday life is contrasted with interaction as mediated through technologies,. e.g. (taken from Ivrea Interaction design website)

"Human life is an interactive life. From birth we interact directly with people and with our environment, using our senses, our imagination, our emotions, our knowledge.

But today, computers and telecommunications allow people to interact *indirectly*. Interactive technologies have become a *medium* through which we interact with each other and with our environment; and they are transforming every aspect of our lives."

(http://www.interaction-ivrea.it/en/vision/interactiondesign/index.asp)

Such contrasts can start to show what new leverage is obtained from interacting through artefacts and technologies as opposed to 'raw' physical interactions with ourselves, each other and the environment. Here, our focus is on how we conceive of interaction in the context of the physical and digital. We could start in a similar vein, by contrasting the two, but given our initial premise to enable seamless integration between the two, it would seem more appropriate to begin by exploring the relationship between the two.

As a starting point, it seems much of our work and ongoing discussions has focused on interaction in terms of adding something extra to the mundane and usual ways of carrying out our lives. Rather than make people's lives easier through using technology to support our activities or mediate our communication, etc, we are interested in how combinations, mergings and mixings of the two can enhance, extend, and enrich people's lives. The shift of emphasis towards 'adding something' that was not there before is quite different from the traditional goals of HCI, which are to improve upon the way people do things (e.g. make it easier, quicker, less errors).

Given our emphasis is on adding to our experiences with life, it is important that we are clear about what this 'added value' is. Importantly, we need to be able to support our claims, and this requires us to consider how we go about designing and assessing novel interactions that give the added value.

3. Added value

A number of claims have made by ourselves (and others) about the benefits of integrating, augmenting, extending and juxtaposing a diversity of digital representations with the physical world of artefacts. These include (some overlapping):

• enhanced coupling between various dimensions of experience (e.g. time and space, the invisible and the visible) making them more seamless, less disjointed and more explicit
• provides more scope for continuous involvement of users with the objects of interest and the activities at hand, which can in turn enable better understanding, more collaboration and enriched experience
• provide new forms of shared experiences that engender a diversity of activities, including story-telling, talking, communicating, reflecting
• engages the imagination in interesting ways, especially when designs are ambiguous

• provides new experiences, not possible with existing media (e.g. extending the now into the past and future in novel ways through recording and replaying digital experiences in the physical)
• provides novel resources for action: that in turn supports more and different opportunities for people to reflect on their experiences
• provides explicit ways of re-representing experiences and knowledge
• provides an extensive and flexible set of ways of allowing people to suspend disbelief and to move in and out of different levels of understanding, experiencing, etc

Each of these needs to be expounded in terms of the boundaries of what is considered to be sufficient. For example, is it enough to say that our goal is to provide novel resources for action. Does this not leave a second chad hanging: why would be want to do that in the first place? What is wrong with our existing repertoire of resources? Each time we make a claim we need to bound the scope of what we are claiming, and to say why this is a sufficient account.

4. Novel aspects of interaction

There are a number of forms of interaction that have been explored in the various Equator projects. Here we focus on the novel forms we have been developing. Along with the rest of the research community, there has been much talk about providing new forms of contextual awareness as a key design concern. In addition, we have designed interaction in terms of engendering different kinds of learning, play and collaboration. For each of these we need to say what we are doing that is the same or different.

Contextual awareness – rather than conceptualise this and limit ourselves to the normally accepted way of 'delivering information at appropriate times and places to allow people to more effectively run their lives (e.g. pop-up reminders of what needs to be done, provision of relevant and 'richer' information at a point in time)' we have started thinking about it in different ways. These include:

Suggestibility
The provision of subtle cues in the form of visual and audio feedback that are suggestive of aspects of the history, personality, emotional well being, etc. of an artefact or aspect of the physical environment (e.g. a house, a chair, a tree, a castle). These might be abstract or metaphorical in nature – the affordances of the physical artefact in relation to the associated digital representations being the critical factor. A key feature in these kinds of designs is to provide an experience for the user/person that causes/enables them to make inferences about its state – which they could not otherwise. The kind of association can range from being ambiguous (causing tensions in the perceiver as they are uncertain as to what interpretation to go with) to 'obvious' and intuitive (allowing the person to make sense readily and if, appropriate, know what to do with the artefact).

Weaving tapestries
The focus here is on providing a seamless experience that is apposite for the users as they make a journey through a pre-engineered set of physical/digital spaces, and which are

triggered depending on the sequencing of the user's experiences and others before them. The key is working out how to design and structure pathways though the tapestry to engender novel experiences.

Mixing realities
<stuff on citywide experiences here>

Learning and playing - Our push on this front has been towards using tangibles and various embodied actions to engender playful learning. By playful learning we are trying to engender learning experiences in children that are both fun and pedagogically challenging. Five core inter-related learning activities are assumed to take part:

- Exploration through interaction
- Engagement
- Reflection
- Imagination, creativity and thinking at different levels of abstraction
- Collaboration.

Exploration is considered central to learning in that it seeks to reduce uncertainty in a novel situation. Engagement with a learning environment facilitates exploration and conversely exploration promotes engagement. Enabling explorative play through a combination of improvisation, creation, engagement and reflection also stimulates independent discovery. In so doing, it can facilitate both the acquisition of information about, and experience with, the environment, together with exploration of different combinations of information, which in turn can enhance creativity. Collaborative activity, particularly *collaborative discovery*, is also considered to be a key factor as it helps children to learn to appreciate other's perspectives, and encourages negotiation, tolerance and the ability to listen to others. The visibility of others actions also enables children to be aware of the effect of theirs and others actions, encouraging further exploration.

Our focus within this framework has been to design interactions in terms of a suite of informational artefacts that have physical properties that can be manipulated. We have been exploring how various kinds of physical objects can be used, combined and digitally enhanced in different ways, to provide interesting behaviours and unexpected outcomes. The key is to be able to design tangible arrangements by which the known and familiar can be recombined in new and unfamiliar ways. We argue that to facilitate this kind of playful learning requires disguising the technology so that the technology itself is not the primary focus for exploration, but rather the interactions with the tangibles and their effects in the digital environments.

<other aspects of novel forms of interaction to be added here>

5. Methodological and evaluation issues

Compared with other paradigms and research agendas in Computer Science/HCI/CSCW, pervasive and ubiquitous computing presents ever more complex challenges, not least,

integrating a bunch of technologies to synchronise and work together to enable the new experiences to happen. Our own experiences of trying to achieve fairly modest designs (e.g. city, citywide, snark) all point to the huge amount of effort required to get things simply to work. Often, workarounds and wizard of Oz-ing is required to enable a critical state of activities to happen together. Our own experiences also have shown that no matter how much one tries to prepare in advance, it is usual for some part of the arrangement of technologies and accompanying infrastructure to break down requiring us to 'wing' it when a session with users, performers, actors, etc is underway. This obviously has important implications, especially whether we can ever build something stand alone.

The timing between a person doing or acting and the responses from the designed space is also critical. A lag in feedback between the two can break the suspension of belief and effectively 'kill' the moment of experience – arguably more so than with more traditional interfaces (e.g. desktop). Such methodological overheads, time delays and uncertainties can be a major obstacle in advancing our work – and needs confronting as they are unlikely to get easier or simpler.

Another key issue we need to address is how do we assess what we do and what criteria do we use to do this? Can we operationalise the putative claims we make about the benefits and added value of our designs and how do we match what the users/people do think or behave. Traditional evaluation techniques like questionnaires, experiments, surveys, etc seem totally inappropriate for understanding the interactions we are trying to design for. Likewise, usability criteria, like efficiency, ease of use, learnability, etc., are inappropriate criteria by which to assess the kinds of interactions we are designing for. Other, more nebulous concepts are needed (which of course will be much harder to cash in everyday concrete terms or indeed 'numbers'). These currently include aesthetics, presence and suspension of disbelief, but we need to consider others, too.

Collection of video, audio and observational notes can provide us with the data but what we do with it is critical. Ethno-based analyses can provide us with some in-roads, but we may need to develop new analytic frameworks by which to 'measure' our designs. Existing frameworks, like discourse analysis, conversational analysis, distributed cognition are from a different era, developed to address the specific needs of the interactions that were the focal points at the time. Hence, we need to consider what kinds of alternative 'interactional' analyses we want to develop, that enable a better understanding of interaction.

6. Where to next?

This is meant as a spring board for further discussion of the issues surrounding 'understanding interaction'. There is lots I have not even covered. A key point of debate that would be interesting to push as now it is beginning to surface in our discussions is:

• Seamless or discordant interactivity

Are smooth transitions between the physical and digital really preferable to ambiguity at the interface. Don't we need jolts or interruptions in our experiences to enable us to learn, collaborate, etc. If all is seamless and effortless won't we all become a nation of couch potatoes?