

Exploring relationships between people, devices and displays

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THE ubiquitous computing vision raises new challenges for the design of novel forms of devices, representations, and interaction and, more generally, for gaining deeper understandings of the user experience in engaging with such an environment.

The **Interact lab** is concerned with the creation of innovative technologies that can be successfully deployed in a variety of real-world settings including schools, public spaces. We position ourselves under the **HCI/interaction theme**, where we see our key driver as not only moving beyond the desktop to explore innovative relationships between the physical and digital as part of a ubicomp environment, but also by including user experience, user data, and the deployment context as key components of the technology development process. This is so that we can explore how interactions between people, technologies, and representations play out in these environments. By means of three projects that illustrate this approach, Equator, Dynamo and eSpace, we discuss our explorations in ubiquitous computing, as well as some of our visions.

As part of the **EQUATOR project**¹, the Interact Lab is involved in developing and exploring the use of new kinds of educational technology, particularly combined physical/digital environments for learning. Moving beyond scenarios in which children are seated at a PC screen, the focus is on determining how to bring physicality and embodiment to the learning process by augmenting physical activities (e.g. walking, moving objects, manipulating objects) with a diversity of digital representations and devices as part of 'mixed reality environments' (MREs), where the real world is combined, in different ways, with a virtual computer based environment. We designed a range of novel MREs to promote new user experiences and to explore issues of embodied learning in MREs as discussed in the following.

Two initial projects were **The Chromarium** (2001) and **The Hunting of the Snark** (2001). The Chromarium is an MRE in which children experienced novel ways of creating and mixing colours using novel forms of interaction involving blocks, light sensors, physical motion and augmented paintbrushes. Studies with children demonstrated how the familiar activity of colour mixing can be transformed into a novel learning activity that can facilitate creativity, exploration and reflection. The Hunting of the Snark is an adventure game where children had to find out as much as they could about an elusive digital creature – the Snark. They did this by walking around a 'cave' where it sleeps, feeding it through a well, and 'flying' with it through digital sky. To achieve this, various sensor-based technologies, devices and wearables were combined, adapted and disguised. This study prompted children to reflect at length on the causal links between the physical and digital spaces they had inhabited, as well as on the nature of the Snark itself. It also highlighted that, compared to GUI-based interactions, these kinds of interactions can be characterised by higher levels of uncertainty, unpredictability and ambiguity.

Based on the experiences gained, the **Ambient Wood** project created two different outdoor playful learning experiences where children could collaboratively explore, experiment and reflect in a digitally augmented physical environment. Making use of a WAN, a wood was wired in such a way that children could explore their habitat discovering, retrieving and transmitting information using a range of devices including walkie-talkies and PDAs, as

¹ The Equator project is an Interdisciplinary Research Collaboration (IRC) funded by the EPSRC. Involving 8 British Universities, it is concerned with innovation and, in particular, exploring the relationship between the physical and the digital. Bristol University and the RCA involved in the Snark project. Bristol, Southampton and Nottingham University were involved in the Ambient Wood projects. Both projects were led by the Interact Lab.

well as not-so-familiar devices such as probes for capturing moisture and light levels, and a 'horn' audio player that played sounds cued by location pingers. Another novel device was a 'periscope' that children used to get views of the wood from vantage points they themselves could not access. The outdoor experiences concluded with a 'den' session where information captured out in the woods was collectively pooled, discussed and reflected upon. In this way a field trip with a difference was created, one that used embodiment and situatedness to enable children to discover, experiment, reflect and hypothesise in new ways.

Other Interact lab projects are concerned with novel forms of information displays and interactivity that will become part of a larger ubiquitous environment when put together with other devices and services. Both are concerned with how people can capitalise on new display technologies to work together more effectively where information access and sharing is at a premium. These projects can be seen as exploring representational components, pointing to new visions of ubiquitous computing in information-intensive industries.

The **Dynamo**² project looks at how to design large, interactive public displays for information sharing and exchange. Based on observational studies at conferences looking at issues involved in acquiring and sharing information, we have developed a multi-user situated display system called the Dynamo board. Located in public areas, the Dynamo board is a communal surface which mobile users can interact with via their personal devices (eg laptop or PDA), moving information to the board, sharing and taking copies; providing interactivity in a manner similar to a digital noticeboard or tabletop system. What makes Dynamo different to its counterparts is its communal (multi-user) nature, since it gives different groups of users the freedom to use the public surface for different things at the same time. To manage this issue we designed a novel screen management tool called 'carving', which allows users to share out the real estate and administer access control on their own regions. A vision arising from this project is the placement of situated display-based interaction at the centre of the Ubicomp problem, augmenting personal mobile devices by providing large, visible interaction surfaces that can easily be connected to and manipulated by both individuals and groups. Currently undergoing user trials, this project illustrates a concern with engineering solutions into real-world problem spaces where detailed observational work has led to technology solutions that concentrate on new user experiences.

The **eSPACE**³ project is investigating how new technologies can help to improve the management of transactions in situations where a customer and sales agent collaborate to specify complex products in face-to-face situations. The transaction space we focus on is travel, e.g., planning round-the-world trips. These interactions can be problematic for a range of reasons including the cognitive and social demands of a complex planning process; the physical arrangement of people and technology; and the design, display and use of representations. Based on observational studies of the problem space, together with research into information design and display, we have designed a new piece of furniture with embedded screens called the 'eTable' that enables customers and sales agents to communicate and interact with information in new ways. The eTable is a shared information space that employs innovative techniques including (i) shoulder-to-shoulder interaction; (ii) dynamically-linked items of information (including geography, budget, and schedule) enabling agents and customers to see and discuss clear visual representations of the product as it develops, and (iii) multiple flatscreen displays which integrate and rationalise the relations between different informational resources. The eTable has been deployed in context, our shop-based evaluations demonstrating that this solution, which integrates new technology with user experience issues, can improve the planning process in face-to-face situations by empowering the customer to take a bigger part in the decision-making process and the sales agent to more effectively manage the transaction. The vision our research invites is of a more seamless transaction across devices, spaces and channels.

² Dynamo is a 3-year EPSRC project between the Interact lab and the Mixed Reality Lab at Nottingham University.

³ eSPACE is a 2.5 year EPSRC funded project (2001-2003), between the Interact lab and Nottingham University