UBIQUITOUS COMPUTING
AUGMENTED ENVIRONMENTS
ARTEFACTS IN DESIGN
GAME INTERFACES
MOBILE GROUPS
MULTIMODAL INTERACTION

PROCEEDINGS OF

THE UNIVERSITY OF QUEENSLAND POSTGRADUATE INTERACTION DESIGN CONFERENCE

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Foreword

Interaction design is a fertile and exciting field in which to be carrying out postgraduate studies. It is a young and trans-disciplinary area, shaped by the possibilities of technology but responsive to the needs of people. For a postgraduate student, this is immensely exciting, but also daunting and difficult. We have established The University of Queensland postgraduate Interaction Design conference (QUIDCONF) to provide a forum for postgraduate students to meet and share experiences, insights, and research interests.

In this, its first year, QUIDCONF has gathered delegates from eight Australian Universities and four states. The papers collected in these proceedings demonstrate the diversity of research currently being undertaken in the area of interaction design in Australia. Some papers deal with the design process itself, while others investigate factors affecting system success. Some explore novel interaction modes, such as gesture, augmented reality and game interfaces and others focus on mobile and ubiquitous computing environments, or designing for particular users such as children or artists. There is also diversity in the research methods of delegates, from ethnographic approaches, to survey-based techniques, to formal experiments. For some, the methods of research are themselves the topic of research.

We gratefully acknowledge the generosity of the academic panellists in providing their time and expertise for the conference. We also thank The University of Queensland Graduate School, The Information Environments Program and The University of Queensland Student Union, whose financial assistance has made the conference possible.

We sincerely hope that the conference will be memorable and rewarding for all involved, and that it will continue to grow in the years to come.

Brett Campbell, Jared Donovan and Clint Heyer
QUIDCONF 2005 Organising Committee
Brisbane, February 2005

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Software Design: Practice Into Theory

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Research Description

My PhD research aims to make sense of software design practice, using the following fundamental research questions, though because of the nature of the research approach (ethnography), these will be refined and others emerge during the research:

- how do people actually design software?
- what is this design activity in practice, performed by professional software designers?
- how do we gain an empirical understanding of software design practice as it occurs *in situ* (i.e. in the workplace)?

Note that the term 'software design' in this research does not refer to a discrete phase in the traditional software development life cycle, as understood by software engineers. It is software design as an endeavour, not a finite stage. It comprises all of the activities performed and decisions made that give some software product its particular shape and form

Research Design

The research methodology I am using is Ethnography, which is both a method (fieldwork) and a product (a written account of the research and its results). The focus is from the emic perspective – the "native's point of view" (in contrast to the etic or outsider's standpoint). It strives to present the understandings and meanings shared in a culture from the "insider's" perspective, and thus "the aim is to 'get inside' the way each group of people sees the world" (Hammersley, 1985 in (Crotty, 1998)).

Research Design

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Ethnographic Method

I am doing a longitudinal field study, 18 months to 2 years, in a local software development company of software design, using standard methods from industrial ethnography and contextual data gathering e.g. participant observation, video-taping, audio-taping, conversations, interviews, note-taking and photographs.

Background on Software Design Research

Before a comprehensive model of software design is constructed, or definitive claims are made about how software design occurs in practice, it would seem reasonable that the following question would have been thoroughly investigated:
what do software designers do in their day-to-day work; how do they actually design software in practice?

There is a sizeable amount of literature on software design methodologies, processes, notations and environments and software design as a cognitive process. It would seem that records of best practices for software design are based on anecdotal evidence or personal experience, and most empirical design research appears to be done in an experimental setting to validate a previously defined theoretical model. More conspicuously, most software design research seems to be from a cognitive perspective, focused on what is going on in individual designer's heads: for example, what are they thinking about as they design; or, how they represent their thoughts and decisions. The extensive and influential work in this area is summarised in a book by Détienne (Détienne, 2002). The approach appears to be: this is a model of how the design process should be performed, let's investigate how well that model is applied in practice; if the model can be validated empirically, it can be offered as an ideal for designers to follow in practice.

But there appears to be a gap in the research into software design: research which observes what professional software designers actually do in daily practice as situated action, to be used as the foundation for understanding software design practice and to build formal knowledge of software design practice. Research is needed which neither puts software designers into artificial design situations (i.e. takes them out of their normal work environments), nor considers only one aspect of the design story, such as cognition.

Lucy Suchman's work on human communication and how it pertains to the design of intelligent machines is especially significant to this exploration of the research into software designer behaviour. Her stance is that purposeful action is always *situated* action, 'actions taken place in the context of particular, concrete circumstances', and that those actions are typically *ad hoc* rather than planned. This standpoint is in contrast to the prevailing view of human behaviour held by cognitive science, which assumes that purposeful action is represented, shaped and revealed by plans. In this model, a plan is something that is in the actor's head which guides their behaviour. These plans for action or behaviour are based on accepted domain principles and theories, and are held to be the primary source for a description of actions in particular situations. But Suchman demonstrates that ignoring the *situatedness* (my italics) of human action provides an inadequate picture of human behaviour and is 'in danger of confusing theory with practice'. By viewing human action as anything other than as *situated* action, we confuse theoretical knowledge with actual performance. Plans are not irrelevant to action, but they do not fully determine the course of action nor can situated action be reduced to or completely explained by such plans. Plans drawn up in advance do not necessarily prescribe the step-by-step course of action eventually taken. Plans used as retrospective descriptions tend to leave out interesting details of the situation in which the action was actually performed and their significance, and thus are an unsatisfactory contraction of what actually took place (Suchman, 1987).

One of the most relevant papers reviewed was by Kari Rönkkö (Rönkkö, 2002) who bases his licentiate thesis on his ethnographic studies of software engineers. The relation between ethnography and software engineering research is explored and he finally outlines an opportunity to combine ethnography, which contributes an 'inside perspective', with software engineering's need for constant improvement. His papers give important insights into the philosophical differences between software engineers and ethnographers, as well as the practical implications of doing an ethnography of software engineers.

Muller and Carey did empirical, ethnographic research on work practices to examine the diversity of working relations and roles of the designers at IBM's Lotus software organisation. They also wished to explore the differences between published reports of design practices in group settings and the practices of the Lotus designers. They discovered that their findings contradicted those of conventional design research in designers use and development of artefacts, practice and knowledge organisation. They wonder whether the design research literature can help inform design practice, or in fact that *'the literature is simply not representative of work, organisations and undertakings like ours'* (Muller and Carey, 2002).

As a result of my literature review, and discussions with several prominent design researchers from various countries and academic institutions, I concluded that what is necessary to investigate software design practice is an approach in which what professional designers actually do in practice is researched as situated action, and used as the basis for understanding software design and for building models that characterise software design practice: putting practice into theory, rather than theory into practice.

Ethical Dimension of Ethnography

This is an empirical issue in my research because it is based on fieldwork focussed on people's work practices. Choosing ethnography as a research methodology within the software engineering discipline is itself an ethical position, and my primary commitment and obligation is to my research participants. Earlier this year, I thus had a comprehensive ethics protocol approved by our university's Human Ethics Research Committee. A direct consequence of my ethics application process was some beneficial discussion between the HREC and people in my faculty using these field research methods, particularly from the Interaction Design and Work Practices laboratory. These discussions culminated in a group research program template which will be used for all future group ethics applications in the university.

Research Work Done to Date

As ethnography was a new research methodology for me, I reviewed ethnographic literature, both ethnography as a methodology and how to implement it practically, and seminal ethnographies. These confirmed my decision to use ethnography as appropriate and valid for my study, as well as giving me valuable insight on the pragmatics of conducting my fieldwork and managing the data collected.

I have spent one day per week during the semester, observing software designers and their work practices in the participating software development company. I have kept detailed field notes, which I have used with subsequent comments and reflections to guide and focus my observations for the ensuing fieldwork. The first months were spent familiarising myself with the technological environment and the organisation of the employees, and very importantly, gaining the trust of the participants. I have ensured that all participants are fully informed about the research and are confident that I am trustworthy and respect them and their work. I have developed sound relationships with several key participants and am recognised and accepted as part of the work environment by all the participants.

The system of work practices, tools and processes in this company are complex and technical and it has taken me several months to gain a useful understanding of what each of these elements are and how they interact. Initially, most of my observations were of the more visible elements e.g. team structure, the physical environment, interactions between individual software developers and teams, emails, user documentation, and the overall structure, interface and functionality of the software product. Now that I am gaining a better understanding of these, I am able to observe the software developers' work practices at a more technical, less visible level e.g. program code, processes for compiling, building, integrating and testing changes and enhancements to the software, as well as the more subtle interactions between the developers.

The software company uses an 'Agile' software development methodology, which does not have a discrete design phase, and one of the challenges in the fieldwork is to identify what aspects of the developers' work are actually design. Whilst these seemed difficult to 'pin down' at first, I am now confident that I am moving towards being able to do that. This has helped me identify emerging research questions in the context of software design. I do not believe this would have occurred without the hours of fieldwork done in the first couple of months. This is also true for my relationships with the participants, and the kind of information I am able to glean from them in informal interviews and conversations. The detail that is voluntarily offered to me is more becoming progressively more technical, possibly as a result of the participants realising that I can understand and appreciate the more technical characteristics of their work.

As I spend more time in the field, I am learning to observe not so much *what* activities, processes, tools and interactions occur, but to give attention to their *significance* to software design practice in the participating company.

I have been very fortunate in that the CEO of the participating company is extremely supportive of my research, allowing me access to whatever employees, processes, tools, documents and interactions I need in my fieldwork.

Finally...

An ethnographic cultural critique does not advocate a particular set of values aligned with a particular social reality but rather, it is the "empirical exploration of historical and cultural conditions for the articulation and implementation of different values" that is the aim (Marcus and Fischer, 1999). My goal is a faithful, accurate representation of a group of professional software designers and their actual, daily activities, interactions and practices which can be used as a basis for further research into software design practice.

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Things to Think With: Understanding Interactions with Artefacts in Engineering Design

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This paper presents the results and implications of an empirical ethnographically-inspired study of mechanical engineering designers and the media they use to support designing (McGarry 2005). In undertaking this research, the theories of Distributed Cognition, Situated Action, Activity Theory and Ecological Psychology were compared and contrasted as means to develop understandings of rich interactive domains. I discuss implications for the design of tangible media, particularly with respect to tools for supporting collaboration and design.

The motivation underlying this research is a discontentment with how engineers physically interact with the technologies designed ostensibly to support them. While the power and sophistication of computer hardware and software continue to develop exponentially, the physical and emotional experience of using a computer is still in most cases akin to that of using a typewriter, though lacking something of the physical satisfaction, tactile feedback and dependability of a typewriter.

Engineers physically interact with space and with a wide range of objects in a variety of ways in order to support their work. Their expressive gestures act out the dance of complex machines or create shapes in space to talk around. They fluidly sketch out rich, multilayered diagrams in personal notebooks, on public whiteboards, on printed design drawings and wherever else they need to think through or communicate their ideas. Engineers' rich physical interactions with each other and with this variety of media stand in particularly sharp relief against their interactions with computers - their strained, mouse-wielding hands make little clicky noises as they hunch over their desks, squinting to see a small arrow-shaped cursor move around a glowing computer screen.

The similarities and differences between using a computer-based tool and, say, a pencil and paper sketch, are observed and experienced in authentic, everyday engineering practice, but this contrast has not been well articulated in engineering research. My intuition is that these differences in interactions have an important bearing on how such tools are used, not only in the engineering domain but in all areas where we interact with physical objects to support our activity. These differences, in turn, have significant implications for those who would design interactive technologies for engineers and for applications outside of the engineering domain.

Part of the power of computers (and more traditional representational media such as sketches and rough mockups) is to allow drastic revisions and reconfigurations to be made to a design with little investment of time, money, labour or materials. Working on and modifying a representation of a jumbo jet is a lot cheaper than modifying a jumbo jet. An inevitable consequence of this decoupling of the 'designing' and 'making' of things is a disjunction between our hands and the things we bring into being.

This disconnectedness between the physical world in which we design and the physical world in which our designs are created is exacerbated by the primitive range of interactions that our computers can recognise. I sense that tangible computing offers opportunities to reunite the physical worlds of engineers with the physical worlds of their designed objects. Perhaps if we can engage in richer physical interactions with the things we design (through augmenting our computer interfaces), we can dissolve the disjunction between our hands and the things we make. In turn, engineers could more fluidly relate their embodied understanding of physical systems and their abstract mathematical representations of those systems. In Clark's (1997) terms, we could put the brain, the body and the world back together again.

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The Importance and Effects of User Research in the Product Design Process for Product Success

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Introduction

Various authors in the field of design research consider users as an important source of information for product development purposes [1,2,3,6]. Traditionally, market research methods are used to make the intended user of a product known [5,7]. Marketing professionals' approaches have some weaknesses, particularly in eliciting user's unmet needs and desires for a new product rather than their preferences between the existing options in the market [4,7]. Direct communication with the user enables the industrial designer to understand the user better and consequently, produce novel ideas for a defined design problem. [1]. In a business environment it is more likely to provide the designer with an opportunity to actively participate in the consumer research along with the design process when there is a clear business or commercial advantage in such an approach. Therefore studying the relationship between user research in the design process and its tangible commercial benefits can promote its application.

Research question

In this presentation the following question will be addressed: *"Does user research in the product design process have a positive influence on the product success?"*
Testing the following hypotheses will assist the researcher to answer the research question: firstly, product success increases with incorporating user research in more phases of the design process and secondly, product success increases through involving users more actively in the design activities.

Method

A quantitative method was employed in this study. A questionnaire with mostly close-ended questions was applied to survey a number of product design projects, which were conducted through both Australian manufacturing companies and design consultancies in NSW.

The level of product success was measured using Likert scale. In this presentation, product success refers to a business improved performance (considering a particular product design project) measured by four of the following criteria: market share, profit, product quality and brand image. The intensity of user research methods was measured by employing an intensity scale. Non-parametric Spearman's test was employed to analyze the data.

Result and Conclusion

Focus of this presentation was the method employed to address the research question. The results support the first hypothesis and reject the second one. Based on the findings, product success increases with incorporating user research in more phases of the design process. However, there were no indications to support the positive relationship between the product success and the intensity of user involvement in the design tasks.

Therefore considering the limitations of this project, mainly the small sample size, further research is being undertaken.

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Is Usability or Utility More Important to Users for System Acceptance?

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The underlying research question for this study asks, is usability or utility more critical to system acceptance by software users? Two software applications were sought out, one that users' ask for and actively seek to use and one that users' claim they dislike using. On the USQ campus the introduction of the knowledge base system RightNow is actively sought and PeopleSoft is not.

A survey instrument for eliciting users' opinions on usability and utility was developed from the models and theories of HCI (Carroll 1991, 2003). Issues relating to Usability Engineering (Neilsen 1993) and the Introduction of Technology (Preece 1994) were incorporated into the instrument to make it a vehicle to assess system acceptance for any software application.

The study will be a three-stage longitudinal study (Wilson 1998) of the upgrade of the two previously mentioned applications. Each stage will have the same elements. The users will participate in focus group discussions and complete the developed questionnaire, System Acceptance Indicator (SAI). The results of the SAI indicate the level of user satisfaction and at the general function level, indicate areas with problematic issues. The DEC SUS questionnaire will be used in parallel with the SAI as part of the SAI validation process. Each stage of the study has a specific purpose. Stage one to establish the status quo. Stage two, run two weeks into the upgrade, to investigate the management of change. Stage three, run eight weeks after the roll-out date to investigate the new established norm.

The focus groups (Morgan 1998) verify hearsay on the software and ground opinions elicited by the SAI. The upgrades are not in parallel. The RightNow upgrade is scheduled for early 2005 and the PeopleSoft upgrade is scheduled for mid 2005.

The proposed schedule of research activities at each stage for RightNow and PeopleSoft is:

Stage 1/II/III

- Elicit from upgrade managers target issues for the upgrade
- Focus group software managers – focus current practice/upgrade target issues
- Focus group software users – focus current practice/upgrade target issues
- Completion of questionnaires SAI and SUS by software managers and users
- Quantitative analysis of SAI and SUS – using spreadsheets and SPSS
- Content analysis of focus group discussions – using spreadsheets and Nvivo
- Feedback to research participants by reporting on issues relating to Usability Engineering

criteria: system acceptance, usefulness, functionality, utility and usability; upgrade target issues and the Technology Acceptance Model (TAM)
- Investigate the role of usability and utility in system acceptance
- Use the longitudinal study to verify and validate the SAI as an assessment instrument for system acceptance.

The foundation for the study is a continuous literature review of software psychology and, the models and theories that underlie the pragmatic tools of software development.

Progress to date

The SAI was developed and a pilot study undertaken to validate the relationship between the user's interpretation and understanding of the questions and the questions' design criteria. The participants used a verbal protocol, which was recorded, while they answered the survey. Adjustments were made to the wording of the questionnaire after the pilot study.

The RightNow focus groups were divided according to roles within the corporate structure. The roles were nominated as manager and user. The focus groups met separately and were video taped. The discussions were transcribed and will be subjected to computer-assisted content analysis. To date a coarse content analysis based on discussion issues has been produced.

The initial survey has been undertaken and the first analysis results produced. Forty-six surveys were circulated and forty-three returned. The System Usability Scale (SUS) by DEC was run parallel to the SAI. The results of both surveys were compared. Ten of the SAI questions were designed to align with the SUS and these results were compared directly with SUS. At this stage, statistical analysis supports the hypothesis that there is a difference between means for the SAI and SUS, but no difference between the means of the SUS and the ten (10) questions designed for the same criteria. Technology acceptance model (TAM) research (Venkatesh, 2003) indicates four principal factors affecting technology acceptance. Of these four, only experience was found, at this stage of the project, to affect the users' responses. A complete draft analysis has been produced in spreadsheet format.

The results of the focus groups and the surveys were reported back to the managers of the RightNow software upgrade. The results confirmed and quantified their subjective assessment on possible problem issues related to their model for the introduction of technology and issues relating to supporting the work in context. The key area of training, in the TAM, which was a concern, was confirmed by both the focus groups and the SAI survey as a problematic issue. The focus groups identified negative issues relating to functionality, utility and usability and, were positive to system acceptance and usefulness. For the negative issues discussed by the focus groups, the SAI recorded lower agreement levels than for the positive issues.

The software upgrade of RightNow is scheduled for late January 2003. The focus groups are scheduled to meet within two weeks of the rollout date. The agenda for these discussions will be based on issues identified in the previous work and targeted for change in the upgrade. The initial responses to the SAI indicate that the users satisfaction with the software varies over a longer time scale than originally considered. Because of this a fourth use of the survey is being considered and the time scale for the survey is to be twelve months after the upgrade.

The output from the focus groups and the SAI has been used to target specific issues for the upgrade, the focus group meetings and to support claims for resources to be used in undertaking the upgrade.

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Using Games for Collaborative Interaction

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A recent trend in the game design community has begun to produce game interfaces that look and feel more realistic than ever before. With new technological advances featured in popular games like Half-Life 2 and Doom 3, including realistic facial deformation and interactive environments, the option of retooling these interfaces for interpersonal interaction is becoming more reasonable. The idea behind the Nexus is to afford some of the implicit exchanges that are seen in face-to-face interactions without the need for participants to be collocated. These exchanges provide subtle but potent meaning in interaction and it is the focus of this study to determine whether game style interfaces can adequately replicate the physical conditions of working and learning environments.

Through use of a 3d game interface, it is possible to simulate a real world environment making work and education more effective, especially for those who grew up playing games often[1]. Additionally, the use of familiar surroundings may make users feel more at home, increasing their sense of ownership and forming a group culture[2, 3], Harrison and Dourish [4] call this phenomenon 'Place-Making', and it has been shown in virtual communities to create groups who are group motivated and self policing. Along with this attribute the effect of flow may be increased. Flow[5], an attribute inherent in most games, stimulates players to lose themselves within the game; it is described by players feeling a general loss of time because of their greater level of immersion. It is possible that this may also affect someone using a game style interface for work or education, making their work seem more enjoyable, while also helping them to be more productive, this effect has been by Koleva et al[6].

Consideration of interactions already undertaken within physical work and education environments was also important in designing an interface for testing. Understanding these interactions was achieved through several means. An analysis of research into office work environments was conducted, drawing upon the work of Lucy Suchman, in the area of organisational procedures in the office environs, and Backhouse and Drew, in recruitment and chance interaction in workplace environments. "The goal of building office information systems requires a representation of office work and its relevant objects ... research into the practical problems of office work, and to suggest preliminary implications of that research for office systems design"[7].

Through user testing of the modified interface, the affordances of physical interactions in a digital environment shall be explored. In the ideal prototype several types of interaction will be tried, including implicit interactions so far only seen in a limited number of virtual interfaces. These interactions include:

- Facial deformation of avatars - It is well known that a large proportion of information transferred during face-to-face encounters is inferred from gestures and expression, this is an implicit form of communication not reflected in most collaboration applications, however with new deformation technology appearing in games like Half-Life 2 it may be possible for avatars to more directly represent the actions of the user.
- Co-location of avatars – Benford said, "implicit awareness of the presence and activity of others afforded by space enables a range of subtle negotiations among its inhabitants. Continual awareness of others allows people to flexibly modify their own activity in social situations. (You can easily see when someone is heading across the room to talk to you or when they are heading for the door)" [8]. This can be literally reflected by providing an environment that mimics the real world allowing obvious awareness of collogues and the environment.
- Mixed reality projections - Avatars, through the use of video streaming projections, will be able to interact with people in the real world and visa-versa. This can be used for instructional purposes to allow online users to feel co-located with their real colleagues, or simply for awareness of what is going on somewhere else. These portals have also been shown to assist in the formation of serendipitous encounters and personal bonding between colleagues.
- Shared workspaces - For users to work on group projects, leave messages for asynchronous communication, or to interact asynchronously with others, the inclusion of workspaces that can be used for writing, drawing or projection by multiple participants will allow group work that is similar to that in the real world.

While only in the preliminary stages, the interactions explored to date have been successful in engaging the participants. While further development and exploration is required, it can be seen that through these interaction types distributed avatar based engagement can occur. The role of game based technology, while not as engaging as physical interaction, can facilitate distributed interaction while containing key affordance from face-to-face interaction.

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Toward an Understanding of Movement-Based Interaction

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Context of Research

In human-computer interaction (HCI), the interaction between humans and computers depends on humans communicating intentions to the computer in such a way that the computer can interpret them [9]. This is coupled with the use of output devices to provide relevant information from the computer in a form that is perceivable by humans. The different possibilities for communication with technology are governed by human anatomy and physiology, meaning the options for input are speech, anatomical and physiological measures, movement (gesture or touch) or a combination of these modes. This research explores characteristics of human-computer interaction (HCI) when the human body and its movements become input for interaction and interface control.

Input and Input Devices

In the early years of computing the *keyboard* and then the *mouse* were great advances in enabling this communication through the use of *input devices*. Since then research efforts have sought to extend input options by creating new input devices and related techniques for the manipulation of objects [e.g. 4, 8] and extending the capabilities of devices to suit new technologies, tasks and environments [e.g. 12].

Although body movements are involved in manipulation of a keyboard, mouse and even more so a tangible interface; this research is concerned with interactions between humans and computers where movements of the body are used directly as the input for interaction.

Human Movement and Intentionality of Action

Movements of the body can effect interaction in two ways, through touch or through gestures. The use of movement as input for interaction relies on the natural paths of movement determined by the body's musculoskeletal system. As such the human body provides both constraints and resources in the determination of possible movement profiles [1]. The way the body moves also indicates which parts of the body could be more suited for different types of interaction.

Labanotation is a system of analysing and recording movement, originally devised by Rudolf Laban in the 1920s [6]. It can be used for analysis and choreography of all forms of human movement. It comprises a symbolic notation, not dissimilar to music notation, where symbols for body movements are written on a vertical 'body' staff. Aspects of human movement relevant to interaction design can be specified in a movement profile.

When people interact with other people, physical, digital or hybrid environments, movement is manifested as intentional actions reliant on the "essential corporeality of human cognition" [10]. Through a phenomenological analysis of perception, Merleau-Ponty [7] described perception as an active process of construction of meaning involving motor action, and motor action as purposeful or intentional action achieved by perception [10]. Embracing the premise of the embodied nature of cognition shapes the way we can think about movement as input for interaction. For example, by learning to use a stylus we incorporate the stylus into our bodily space to initiate interaction. In contrast, when using movement as input for interaction we do not have to learn to use a new device, but we are reliant on the *potential for action* that has been designed into the technology. This is to be taken in the sense that technology poses certain constraints on and/or opportunities for our actions as natural movement, but also in the sense that what an action means depends on the intentions of the user [11].

Research Design

Using these theoretical foundations, the focus of my research is to investigate characteristics of HCI when movement of the human body becomes the input for interaction. The outcomes sought are to develop:

• an understanding of the techniques currently used;
• an evaluation of the effectiveness of these techniques;
• new interface and interaction design principles which can extend existing user-centred design guidelines; and
• new evaluation methods that can extend existing user-centred design methods.

It is envisaged that a consideration of these steps will lead to more appropriate frameworks for interaction design. The research will be undertaken in three parts; each phase will be used to refine the research questions, and to determine the appropriate setting for further studies.

Progress to Date

The first phase aimed to identify the techniques used by current systems to represent and characterize movement of the human body, as well as consider ways of evaluating systems that rely on movements as their source of input. An observational study of two computer games that use movements of the body as input, was carried out. Computer games were chosen for the study as they are easily accessible, existing systems. Eight participants were invited to play two games using the Sony Playstation 2® Eyetoy™. Data on demographics and previous experience with the games was collected prior to playing. The participants were interviewed about their experience with the games, and asked usability related questions during debriefing. Methods used were adapted from participant observation and usability evaluation.

Interaction with the two Eyetoy™ games, Beat Freak and Kung Foo, produced a range of movements, primarily movements of the torso and arms. The movements were performed either as a *command in the selection of game choices and settings* or *reflex response* by hitting either a stationary object; a moving object by coinciding with target location; or moving object as soon as the object appeared. These movements were analysed using Labanotation [5]. When transcribed, it became evident that each game has its own set of basic movements that enable game play. Laban's Effort-Shape dimensions of space, time, weight and flow, illustrated that each participant played with individual styles and characteristics. The Effort-Shape dimensions provided detailed qualitative descriptions of these distinctive movements. It remains to be discovered whether any of these styles produce more effective game play. The Eyetoy™ interface is tolerant of movements with different characteristics, provided that the movements take place within range of the sensor.

The second objective of the study involved the use of two frameworks, *Sensible, Sensable, Desirable* [3] and *Making Sense of Sensing Systems* [2], for evaluation of movements produced by interaction with the Eyetoy™. Evaluation using the *Sensible, Sensable, Desirable* framework showed what constraints the interface places on the movements of the user. In contrast, evaluation using the *Making Sense of Sensing Systems* framework demonstrated that interaction as a form of communication in terms of simplistic movement profiles is possible, but this framework does not focus on the movements themselves in the interaction. Both frameworks revealed insights not exposed by standard usability evaluation principles. On the other hand, neither framework uncovered the set of usability issues observed during game play and articulated by the participants either during game play or in the debriefing session. These were issues of *feedback* and *visual clutter* in the interface. The two games studied produced quite different movements. Kung Foo produced a variety of strong, fast movements in all lateral directions in space. The expressive force applied by players whilst defending themselves from attacking henchmen suggests that a movement needs to be considered within the context of its performance, particularly its underlying intention. When designing systems that rely on movement as input for interaction, it may be useful to examine, not just the communicative intent of the movement, but the effort required for performance of that movement as well.

The second phase of this research will see the development of a taxonomy for physical interaction as emerging out of a review of the literature and the first study. This taxonomy will identify and define the relationships between movement profiles as presented by the body and potential for action as designed into current technology. The next study is a participatory design study that aim to develop and evaluate low-fidelity prototypes testing findings from phase one as well as testing the taxonomy. The third phase is dependent on the preceding phase; however, it is envisaged that this study will test the design principles that have been developed. The results of the second study and more concrete statements about the third phase will be presented at the QUID conference.

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Interaction Design for Ambient Intelligence and Tangible Media

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Overview

Despite there having been many technological advances in the past decade, Weiser's[13] vision of ubiquitous computing has not come to pass. His notion of individuals having access to many personal computing devices at several scales (tab, pad and board) was based on ethnographic studies of work at Xerox PARC. The resulting systems were heavily document centric both in their form factor and in the modes of interaction afforded.

This vision entailed a divergence of physical form factors and a convergence of data into centralised network storage. Each of Weiser's devices provided a "window" at a different scale through which you could view and work with your data. This world view heavily influences the types of interaction that are considered.

However, over the past decade devices at many scales have become increasingly available. Due to various economic, technological and social factors these devices are highly differentiated in terms of functionality and form, providing access to network bound and local data. Here data is fragmented, redundant and scattered across a range of devices and data repositories.

In this environment the types of interaction that need to be considered and the approach to interaction design are quite different.
Some more recent work however has begun to describe these complex and realistic pervasive computing environments. The literature on Ambient Intelligence[1] and Tangible Media[8] has described a range of devices and interaction modalities. Tangible media and embodied interaction in these spaces bring representation, manipulation and performance together in the same place, in a way that forces us to rethink how we approach interaction design.

Despite a good deal of early work in the formal analysis of interaction for these types of spaces[3-5] and attempts to map out the design space[6, 7, 12], current tangible media systems often utilise trivial mappings between the interface and information spaces. While many one off tangible media systems have been produced, these are problematic as they are often designed to solve a single, hypothetical problem.

In addition to this, artefacts in these systems often have arbitrary form factors. Clearly many issues of representation have yet to be resolved.

More recently, authors have begun to articulate typologies and frameworks that map out the relationships between existing systems and suggest trajectories for future design efforts[6, 11].

All of this presents difficult problems for the interaction designer. For tangible media systems to be more widely accepted and integrated into the intelligent environments of the future, we need to have an understanding of the multiplicity of mappings into information spaces.

In addition to this we need a better understanding of representation issues and ways in which composite and modular approaches to interfaces have an impact on design and use.

Contribution to the Field

This work will make a contribution to the field by:

- describing a modular and constructive approach to tangible media, allowing the user to build the device or tool they require for a given task context;
- describing different classes of archetypal devices and tool functionality, allowing designers to build modular tool components at the right level of granularity;
- describing a representational system for intelligent artefacts and the spaces they inhabit; and
- mapping tangible media constructs onto a range of consumer devices to support embodied styles of interaction.

In particular this work is aimed at users who wish to describe and maintain a Personal Media Architecture (from Espen's Personal Technology Architecture[2]).

I will also contribute to writings on topologies of tangible media systems and how tool metaphors[9] and gesture can be better utilised in these systems.

Further to this the impact of new material technologies on interaction design will be examined. These new materials will lead to a variety of novel interactive artefacts. Some prototype devices in this family have been developed and tested recently such as the Gummi[10] flexible computer.

Relevant Research Questions

The research questions that have come out of this work so far include:

Are existing typologies and frameworks for design of tangible media systems adequate to accurately describe a Personal Media Architecture?

If not, what extra dimensions need to be added to these systems?

Can abstract archetypal tools and devices be described and how do these map to physical artefacts?

What representational systems are required in order to adequately describe components of a tangible media system and the spaces that they inhabit?

Is it possible to describe the mappings between artefacts and the digital objects they refer to in terms of their physical context?

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Usable Ubiquitous Computing: Integrating the technical into participatory design

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My research is focussed on creating usable ubiquitous computing systems using participatory design with an emphasis of increasing the level of communication between engineers, designers and users. My thesis will examine the effects of engineer involvement in a participatory design process and how it influences the resulting systems.

Having observed how computing is currently used in dental surgeries and its current deficiencies, I aim to design a system that improves human computer interaction using multimodal ubiquitous computing. Multimodal interfaces are useful not only due to their more natural and efficient interaction [1] , but particularly in the domain of a dental surgery they provide means to support infection control procedures. However dentists are also required to have high levels of concentration on the patient, and breaks in this (to update the patient record for example) can detrimentally affect their work. Therefore a ubiquitous computing system that allows the dentist to focus on their procedure rather than driving the interface is desirable.

Furthermore, in my research I have found a trend amongst ubiquitous computing systems towards technology development rather than usability development. There is a strong technical approach favoured by many researchers in the field, and it is my belief that ubiquitous computing technology is sufficiently mature to allow a shift in focus from technical milestones, to creating systems that 'fit' a domain and support the users and their work practice within the domain.

However, in using participatory design to help create a more usable design I found that the traditional approach of using designers and users to derive a technical specification that is then given to engineers to implement was insufficient. My approach was to integrate the engineer into the design team for two reasons. Firstly, the engineer assisted in constraining and directing "drift" in the design towards technically feasible approaches. Secondly, the engineer was needed to intelligibly explain new technology to users so they are able to better understand and accommodate changes to their workplace and to allow them to better inform the engineer as to potential problems in the design. This cycle of understanding (of the engineer understanding the user, and the user understanding the engineer) was extremely useful in developing a system that, so far, has suited the users' domain and work practices.

The participatory design process I am using makes use of ethnographically inspired fieldwork and contextual interviews (to provide an understanding of the domain of the practitioner), design games and workshops (to initiate discussion and involvement with the users), and design discussions (to help propel the design with both user and engineer input). I am also using video analysis techniques such as the Video Card Game [2] to support my research.

To date, I have run several successful workshops with dentists and have prototyped several ubiquitous computing applications (such as a digital pen interface to the dental record) and am focussed on completing a final system that allows for updating the patient record during a procedure without interrupting the dentist's work practice. This system currently makes use of speech recognition and will hopefully soon incorporate gesture recognition and context detection through technologies such as RFID tags.

My plan from here is to finalise the ubiquitous computing system derived from the participatory design approach and test it with dentists during actual procedures. The results of this will inform my analysis of the usefulness of engineers in a participatory design methodology.

In my thesis I aim to critique the participatory design process and document the effects of engineer involvement; critique existing ubiquitous computing design approaches and offer a framework for designing ubiquitous computing using a participatory design approach; and finally, evaluate the success of systems resulting from this design process.

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Understanding Mobility

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With the emergence of mobile technologies, traditional user-centred design approaches to IT systems design are being applied to new contexts. User-centred IT research fields, such as participatory design (PD), human-computer interaction (HCI), and computer supported cooperative work (CSCW), currently have a good understanding of design for human computer interaction in a fixed context, however this is not yet the case for mobile computing (Johnson 1998). In particular, mobile HCI practitioners are facing a number of issues in translating techniques developed for a single context to a moving domain. "When computation is moved "off the desktop", then we suddenly need to keep track of where it has gone" (Dourish 2004, p. 19).

Two predominant research questions to-date within the mobile HCI literature have been firstly, the relationship between a device's physical form and activity, and secondly, the relationship between a device and its setting (Dourish 2004). The latter issue of how to embed the notion of context into a device's functionality has been highly influential, leading to the question of understanding what context actually is, eg. Bradley & Dunlop (2002), Dey (2001), Tamminen et al. (2004). In particular, the different elements of context have been difficult to measure, with aspects such as the social situation not yet identifiable (Kaasinen 2003). Context, however, is not the entire problem for the design of mobile computing systems. Johnson notes that "to contribute to the design. of mobile systems we need to understand what the design problems of mobile systems are" (1998, p. 6).

An aspect of mobile systems, starting to be addressed within the literature, is the concept of mobility and what this means for the design of mobile technologies, e.g. Luff & Heath (1998), Kristoffersen & Ljungberg (1999), Kakihara & Sorensen (2001). Luff & Heath note that mobility has been largely overlooked within CSCW and state:

> We suggest that taking mobility seriously may not only contribute to our understanding of current support for collaboration, but raise more general issues concerning the requirements for mobile and other technologies (Luff & Heath 1998, p.305).

In addition, methodologies and research methods used to date by the mobile HCI community have been identified as clearly biased "towards building systems and evaluating them only in laboratory systems, if at all" (Kjeldskov & Graham 2003, p. 1). Kjeldskov and Graham note that field studies are infrequently used and could be applied in the future for understanding mobility by using ethnography to study current practice.

As such, the aims of my research are to develop a comprehensive empirically derived, conceptual understanding of mobility that can support differentiation between human mobility, device mobility and the characteristics of activities that we can consider 'mobile'. In addition to this, I aim to extend existing field study research methods that have been developed for traditional, stationary technology devices, so they can be successfully applied to the development of useful and usable mobile applications. In particular, I am investigating the following questions:

- What is mobility? What are the primary purposes of mobility? What are the existing assumptions about mobile device usage and mobility?
- How does the mobility of particular artefacts, specifically mobile wireless devices, support the work and social practices of users? How are mobile wireless devices currently used in practice?
- What are the usability issues specific to mobile applications and how do they compare to existing understandings of usability issues in technology design?
- In what ways do use scenarios, used in the design and development of mobile applications, need to differ from standard use scenarios?

To address these questions, a qualitative approach to research has been taken in which empirical studies allow us to understand a person's lived experience of the world from their perspective. In contrast to a technology driven approach to mobile device design, this research instead places the user first by considering a person's social and work practices, the role that mobility plays in these practices, and how carried artifacts support a person's mobility. As a starting point for empirical studies, I am currently conducting an initial series of eight to ten pilot interviews with freelance or contract workers. This group provides a rich picture of mobility in that: participants revolve through job roles and geographical locations throughout the year; their practices change between work, out of work, holiday, and social periods; and they may also work at a fixed office location for the duration of the job or work at remote sites intermittently. As an initial pilot study, this study is exploratory and will be followed by further empirical studies, as yet to be decided, such as shadowing of mobile device users, further interviews, cultural probes, etc.

A large part of my research to date has been upon scenarios and their role within the HCI and mobile HCI literature. Two ideas that have emerged from the recent mobile HCI literature on scenarios are: firstly, acting out scenarios in the real world to situate them, e.g. Iacucci & Kuuti (2002), or secondly on somehow specifying context within scenarios to improve design processes, e.g. Pedell & Vetere (2004). Initial thinking that I have done so far, on how to apply scenarios to device design in a mobile environment, involves asking the following types of questions:

- If design representations "hide some details so that the important aspects stand out" (Benyon & Imaz 1999, p. 163), which elements of the mobile situation do we need to emphasise in order to design effective mobile devices?
- How does the context of work at a desktop differ from the context of mobile work, i.e. context occurs in every situation, what is it exactly about mobility that brings the notion of context so strongly into the foreground of debate? what's missing?
- In what ways have scenarios previously been extended or recently applied to the mobile situation to improve their role in design? e.g. plus and minus scenarios (Bodker 1994), development of a range of mobile scenario types (Kristoffersen et al. (1998)), extending scenarios with non-functional requirements (Rosson & Carroll (2000)).

This research on scenarios is currently being developed into a paper that will be submitted to a conference in mid February.

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Challenges Observing Mobile Groups of Users

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Abstract

Many research methods exist to help understand mobile behaviour of users. Most do not focus on contextual issues or group behaviour. Additionally, they have usability problems hindering their effective and widespread usage. The paper reviews difficulties we have had using the methods and suggests possible improvements.

Introduction

A variety of methods have been used to understand mobile behaviour including: shadowing [12], remote usage tracking, simulated movement in labs, technology and cultural probes[6], self-video [7], and diary studies [11]. All of these methods have difficulties and many of them don't focus on contextual effects and group behaviour. A number of usability issues for researchers and practitioners need to be addressed to simplify mobile field studies and encourage their use.

Up until recently, a great deal of mobile research has been oriented towards actual development of working systems and there has been a deficit in field studies or in-context evaluation of mobile devices. It has also been noted that mobile studies are often more difficult to run [8] and the data is more difficult to analyse following the study. Many studies examining mobile, group usage have struggled with methods for capturing and depicting relevant group behaviour and contextual variables. A study of a mobile hunting group used participatory observation and written notes to observe group behaviour [5]. Harr mentions that, "I made notes while moving in the group. This was quite difficult since I was also a participant and since I was mobile as well." (personal communication, 2004). There are also challenges to using diary studies and Experimental Sampling Method (ESM), including problems with writing in certain contexts or while moving [9, 11]. Other researchers have reported difficulties observing mobile behaviour using shadowing, which alters the social and physical environment [7].

Researchers use a variety of methods of logging data during mobile field studies. Paper-based notepads are still common. Diary studies often use sticky notes [2] or paper journals [4]. Attempts have been made to digitize the logging process by use of voicemail and video clips [7, 11]. Video is used, but researchers frequently complain about the time necessary to review it and few tools for summarizing or scanning it quickly. Text entry on mobile devices is a problem when users are actually moving inside a changing context. "This means that they cannot devote all of their attentional resources – especially visual resources – to interacting with their device; such resources must remain with their primary task, often for safety reasons." [3, 9] This is true both for users engaged in typical mobile activities and researchers trying to log data about their activities.

Data Collection Issues In Previous & Current Work

We have conducted several field studies [1] related to navigation and communication behaviour and are beginning several diary studies. A number of problems have been encountered during use of various research methods that are related to their mobility. Taking notes while walking or running after participants proved difficult. We settled for brief shorthand, structured logs and messy writing to compensate. Taking photos while mobile is a reasonable method, except in certain social situations, while trying to do other logging activities or when movement needs to be captured. Diary study methods requiring written self-reporting suffered from similar input issues. Participants regularly had to stop the activity to write, or slow movement and risk walking into objects. The same issue affects experimenters who need to watch where they are moving while doing data logging. We experimented with using tablet computers, to review photos to establish location after the study is complete. This worked well because it allowed viewing the photos in a large size format, but glare issues and disturbing the social environment with novel technology was an issue.

Analysis of mobile data is equally problematic. Triangulating and aligning data from multiple sources such as notes, cameras, video, logs and self-reporting often requires custom tools. A re-creation of a summary of simultaneous behaviour across multiple people for distributed group activities is sometimes needed. We have developed several methods of visualizing and organizing data, using both dynamic web-based tables and static diagrams. Getting data into these analysis tools is time-consuming if the original data set is not digital. Particularly converting hand-written notes to text files and getting data out of image files into databases was labour intensive.

Discussion

Researchers using technology to log the behaviour of mobile users become an additional user group to the primary users who are perhaps using the same device for the activity being studied. Digital input methods were considered as an alternative but the tablet computer interface was error-prone and glare issues with the screen made it infeasible to use for rapid, outdoor data entry. Thumb keyboards or predictive text on handheld devices are an option for mobile data logging, but the amount of visual attention they require makes them inappropriate for fast-moving studies. It is also important for the observer to remain aware of the external context, behaviour of the user and other issues while logging data. This means that eye contact is at a premium for other tasks. It may be possible to use handheld computers for studies where pausing to take notes is appropriate.

If possible, any data logging methods should be trialled before the actual study to understand the structure of the data they produce. In some cases it is possible to automate or set up the importing process of this data before the study so that it can be done rapidly after it is recorded.

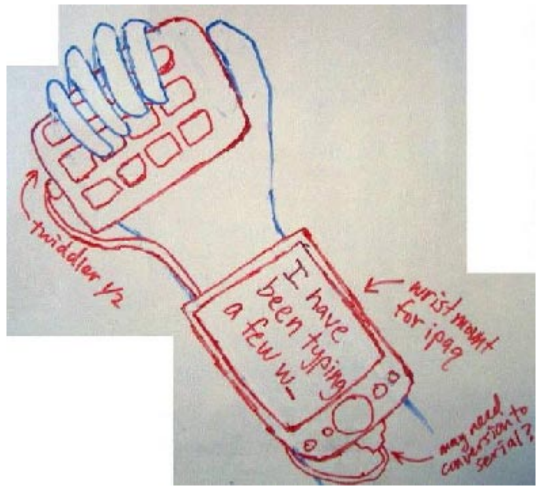

Figure 1: A low-fidelity prototype of a mobile data logger with a chord keyboard

Future Work

We are currently looking at ways to simplify mobile diary input by participants and integrating the concept of form-factor into data entry. Postcards appear to be an inexpensive method, although cheap handhelds or phones may be a reasonable option. For rapid data logging by mobile observers, it may be possible to use chord keyboards. A paper prototype of a PDA attached to a chord keyboard is shown in Figure 1. The device would theoretically allow extensive text entry at speeds up to 67 wpm [10] and allow eye contact to maintained with participants while note-taking.

Conclusion

There are a variety of issues with mobile research methods including the structural weaknesses of a particular method (e.g. observer effect), physical difficulties recording observations, and analysis problems with large and diverse data sets. Steps can be taken to diminish the effects of these problems, but mobility inherently complicates investigation.

Acknowledgements

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Legibility/Readability on Screens: From readers to users in human centered technology design

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Today, text appears in many different visual forms. Choosing typefaces, combining and arranging them, thereby structuring textual information to make it meaningful for readers, is undertaken increasingly with and mediated through Information Technologies. Not only is the display of text part of the domain of System Design and New Media, textual information can be seen as basis for so called Information Spaces, such as the World Wide Web or Mobile Networked Environments, where one or more people search, gather, share, use, distribute or preserve information.

The moving type, scrolling texts and the serial visual representation of textual information on a screen or a device display, have to be acknowledged as major changes of how we consume text today. The understanding of how text works in an on-screen environment is integral to designing optimised communication processes with the user. Visual, active, reactive and dynamic aspects of text are "experienced" rather than read.

Two areas for understanding reading have emerged during the initial phase of my research, spanning from deciphering of alphabetic signs to the transfer from code to meaning. These approaches are rooted in the differences found in the terms readability and legibility. Legibility is defined as "the visual clarity of text, generally based on the size, typeface, contrast, text block, and spacing of the characters used" (Lidwell, Holden & Butler, 2003, p.124). Although this description lacks several variables in terms of what constitutes legibility, it associates legibility with visual factors. Readability is "the degree to which prose can be understood, based on the complexity of words and sentences" (Lidwell et al., 2003, p.162). Readability therefore points towards the semantic relationships within a text and how readers create meaning from textual information. These definitions underpin the notion of reading as deciphering (legibility) as opposed to reading for comprehension (readability).

These two areas of understanding lead to a third one, the conceptualization of reading as a human centered activity where the reader can be seen as the user of a text, opening the discussion towards textual usability. The shift from the writer to the reader as the one who, creates meaning out of a text is reflected (but not only displayed) in hypertext, where a text is an open web of references, rather than a closed work of perfectly linear narrative (Lupton, 2004; Barthes, 1971). To progress these three concepts and their interrelation I propose the following studies and original research:

Reading as deciphering and the focus on technical attributes of fonts and their use, such as type form, font size, word and line-length, etc... The literature reviewed so far deals with the deciphering process and character recognition as well as technical attributes of fonts and their use in print and in on-screen media (legibility). A draft paper outlining the findings has been written.

Reading for comprehension and the emphasis on semantic relationships and spatial arrangement within texts, as well as the sequential perception of content and the enhanced possibilities of textual display and their influence in creating meaning. The comprehension aspect in reading (readability) - especially in screen based New Media - will be addressed in a qualitative study and underpinned by several critical evaluations of case studies in the area of active/reactive/interactive typography. The "Bystander Field Project" – the work in question for the qualitative study –, is an immersive "feedback" environment for exhibiting and dramatically interacting with semiotic, aesthetic and emotional patterns in archived imagery. It uses several levels of expressive/kinetic typography, which will be focus for a planned protocol analysis. The study will commence early this year.

The **Human Centered Approach** to reading finally will reframe the user of a text in the context of use in information spaces, using services such as email and sms, with a focus on mobile device displays. How reading from screens differs from reading from paper, drawing on both, a) legibility and b) readability findings, forms the basis of the Human Centered Approach in my study. This question will be addressed through a second qualitative research project, trying to find out about on screen reading habits of participants and their awareness and experience with enhanced textual display methods of typography on screens. This study is in the planning phase and will commence early 2005.

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Navigational and Desktop Environment Design within Augmented and Virtual Reality Utilising Head Mounted Displays

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Abstract

This paper outlines the current investigation and proposed design of interaction representations for varied interaction tasks within a virtual or augmented environment.

Existing interface systems allow for the representation of data manipulation and navigation via two-dimensional structures. With the emergence of virtual reality systems in areas such as medicine, military and entertainment, there becomes an opportunity to transform the limited representation systems into one that takes advantage of the new environment. The proposed design will incorporate application menu systems and the modes of interaction with objects within the environment.

Applications of an interface such as this could be found within a range of fields. Military training currently makes use of virtual simulation and this could provide access to information needed within operational procedures. Similar technologies could be adapted for pilot control systems within a visor display. For medical research, where virtual exploration of surgery is used, information could be accessed within the operating environment that had otherwise been contained in adjacent systems. Real world application of this model would be limited at this time by the use of the appropriate computing power; however, the future use of this study could have broader application within the development of game technology, internet access and data mining.

Subject to funding a proposal for a prototype of the interface will be produced and assessed via user interaction and response and measured through numerical analysis of the results. This prototype will include a demonstration of the base interaction with the operating as well as the operation of a simulated software package. The prototype will be viewed via either a virtual environment or augmented environment and the interaction will take place via the use of either mouse or data-glove. Each interface or interaction technique presented will attempt to follow the principles stated in Bowman's VE Interaction Guidelines (Bowman, 1999).

Motivation

Research into Virtual Environment (VE) interface and interaction has been continuing for many years, since the introduction to the concept appeared in the 1960s (Sutherland, 1968). There have been a large number of individual research developments, usually for specific application and developed on an ad hoc basis, suiting the needs of specific applications or situations. Guidelines developed by Bowman on interaction techniques (Bowman, 1999) and Gabbard's (1997) usability studies have helped to establish a common reference point for user interaction in VE.

The project will endeavour to use these and related research examples to develop an interface system for interaction for use in virtual and augmented reality environments. The increase in computing power and associated technologies over the past few years has facilitated the increased capabilities of VE systems and improved visual displays. One such technology is the introduction of Head Mounted Displays (HMD) to more wearable glasses, rather than a cumbersome device that encompasses the entire head. Developments using direct retina projection allow the equipment to be further improved in an ergonomic sense and will invite many new applications for augmented reality.

There have been several advances in the physical tools of interaction that have progressed along side the computer and display evolutions. The continued development of high and low end haptic devices is leading towards more manageable and comfortable methods of interaction. The use of vibratory feedback for example (Lindeman, 2002) via simple use of rotary vibrators from mobile phones has proven to be a successful method of providing feedback.

Problem Statement

Analysing the methods and interaction tasks within virtual environments is a difficult process, given the diverse nature of the systems currently in use and the project specific requirements that each interface and interaction structure has required. Despite this, there has recently been several studies in this area, building taxonomies of interaction tasks based on the existing systems and going back to the basic studies conducted for the development of 2D interfaces (Foley, 1979). Bowman provides a framework for reducing interaction tasks into four general categories; travel, selection, manipulation, and system control (Bowman, 1999).

Travel being the movement of the user or at least the users viewpoint or the actual traversal of the VE world. Selection, being the process of differentiating one virtual object from another in order to interact with it, this is appropriate for objects, navigational devices and control elements. Following on from selection is manipulation, which constitutes any action or process that affects the original state of the selected object, such as repositioning, change in scale or using a virtual tool to initiate some form of behaviour. The last of the general task categories is system control, that is the process through which the user can initiate changes in the system behaviour from within the VE. This may be as simple as saving a location or changing to a different VE application. For augmented reality systems, this interaction could be the opening of other applications or establishing a network connection.

It is evident from the literature reviewed so far for this research that little has been reported or published with respect to the visual nature of the interaction tools. Studies have to date focused more on the mechanics of the elements, developing novel methods of interaction and attempting to recreate either 2D widgets or real world analogies. Despite the differences in focus these studies have produced a number of guiding principles which will form a baseline measure for the findings in this paper.

The Objective

The area of investigation here is the assessment of various modes of interface on the ability of users to perform a predefined list of tasks. It is expected that users with varied computing experience will have different reactions to the prescribed tasks and interfaces and will be able to provide useful feedback as to which interface design, or elements of, is preferred. The outcome is to provide some form of additional guidelines to those already collected with respect to the actual visual nature of the interface and its elements of interaction.

Progress

This research is in the early stages of development. Currently still in the literature review and project design stages after changing course from original direction, after it was assessed internally as to broad an approach. The project has gained focus, looking more at the visual design rather than including studies into the mechanical process as well and the development of specific input devices.

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Methods for Testing Transition of Affect Induced via Media elements

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Information technology is becoming increasingly ubiquitous in our lives. Most of our personal and professional lives are now stored on a network somewhere, more of our conversations occur over the Internet, we are offered new ways of spending our leisure time on the net everyday, we are even told that our refrigerators should be connected. A multitude of research and development projects have arisen to facilitate the new pervasiveness of computing. We are trying to find ways to merge the network infrastructure into our physical surroundings; to enable us to locate the correct piece of information from a sea of data; to be contacted regardless of our location; to allow our clothes to communicate with our washing machine.

But what of our feelings? How will this new digitised world leave us emotionally? In the ubiquitous computing utopia we will be constantly surrounded by objects wishing to communicate with us. As outlined above, much of the research to date has been into the infrastructure necessary to make this possible. Most HCI research has been into how to make the interactions as seamless and intuitive as possible. But until recently there was little attention paid to how this environment would make the user feel. In the mid-1990s Rosalind Picard of MIT began the investigation of what is today referred to as Affective Computing. The Affective Computing group has many areas of research including the sensing of human affect, communication of affect, the synthesising of affect in machines and understanding and modelling of affect. They are not so interested, however, in influencing the users affect. I am interested in how the new ubiquitous computing environments and in particular the multimedia aspects of such environments, could influence a persons emotional state. Increasingly these environments will be able to read the emotional responses of the people in them and respond in some way. Using the media aspects of such spaces to induce an emotional response may be a useful ability in certain circumstances. Maintaining stress levels of air-traffic controllers would be a classic example. Being able to lead a game-player along an 'emotional plot-line' would serve to make a game-environment more captivating.

My research aims to examine the effect of multimedia environments upon a person's affect. By examining the relationships between various forms of media and a person's mood we can develop tools which aid designers in creating affective-media elements. We can, as well, develop a set of recommendations for informing the design and evaluation of media aspects of systems, either interactive or unimodal, with respect to the transition of a user's mood from one state to another.

The aims of my research are:

- To investigate the causal relationship between various forms of electronic media and a person's mood or emotions and the effectiveness of different media elements for inducing a transition in mood;
- Develop recommendations for the design and evaluation of media aspects of human-computer systems and spaces with respect to the ways in which they are able to induce a transition of mood in users.

To realise these aims my research will follow an iterative procedure of:

- design/construction of affective media tools and an affective computer gaming environment;
- testing/evaluation of the effects of the game on a person's moods;
- data analysis;
- further refinement of the design/construction of the tools and environment.

It is anticipated that three iterations of the study will be necessary for adequate data collection.

For each iteration of the study a body of participants will be recruited and each participant will be randomly assigned to one of three groups. One group will be exposed to a game designed to induce a negative mood state, another to the unmodified game and the third will be exposed to a game designed to induce a positive mood state. None of the groups will be made aware of the intent of the study until they have completed the final self-report questionnaire (SRQ). Each participant will be taken to a room to complete a SRQ then asked to go through to a second room and play the computer game for a period of time before coming back to complete the second SRQ. The subjects will be told they are evaluating certain playability aspects of the game so that they will not be concentrating on the media aspects of the game or their mood. It may be necessary to de-brief the participants.

Analysis will be carried out on the data received from the studies to ascertain what, if any, effect the media had on the participants moods/emotions and which media aspects had the greater influence. Open ended questions may be included on the second SRQ in an effort to uncover any effects/anomalies which were not expected. The data from each study will be used to re-design the media elements of the game for subsequent studies.

From the studies and the final literature review a design will be made for a fully automated, responsive affective-game, recommendations for designing/evaluating the affective media aspects of games and information spaces in general will also be created.

Influences

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Factors in Designing a Concept Mapping Tool for 3-to-5 Year Olds

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This paper describes current research into GUI design of a computer-based concept mapping tool for 3 to 5 year olds, for use in educational settings. The project aim is to identify the interface and interaction elements that would facilitate the manipulation of concept maps by young children. Later these findings will be used to guide the creation of a pedagogically sound cmap software tool, designed on child-centered principals, to: one, assist preschoolers to articulate representations of conceptual relationships (propositions) using images and sound; and two, allow preschool teachers to effectively train children in concept map making. The concept mapping tool would enable children to give meanings to images representing their understanding of a particular piece of knowledge, and make explicit the conceptual relationships they are creating. Students will be able to attach sounds to images in the cmap, in order to assign a precise meaning to the word or concept.

The research study builds on the concept mapping literature; the ability of young children to represent and communicate knowledge with symbolic and verbal language (Brunner 1968 in Brooks and Dowley 1990); and the experiences documented by teachers using concept maps in preschools. A child-centered approach, based on Donald Norman's user-centered product development process (1999), is being used to analyze users (children and teachers) needs and interactions with tasks relevant to the concept mapping activity. Documentation and prototypes resulting from the analysis will be used to write design specifications, in the form of a manual, explaining how the tool should work.

Concept maps, otherwise known as cmaps, are tools for representing and organizing knowledge. They are comprised of individual concepts, which combined form meaningful relationships, called propositions. Concepts are usually enclosed in circles or boxes and connecting lines that link them together. Linking words on the line represent the relationship between two or more concepts. Single words usually used to label concepts, but symbols can be used as well. Concepts within cmaps are represented in a semi-hierarchical manner. The most inclusive, general concept is positioned at the top of the map, and the more specific, less general concepts arranged below. The hierarchical structure for a particular domain of knowledge also depends on the context in which that knowledge is being applied or considered. Therefore it is better to construct cmaps with reference to a particular question we seek to answer. Grounded in Ausubel's Theory of Meaningful Learning, cmaps were invented by Joseph Novak in the '70 as tool for evaluating children's knowledge in science. Scientists, school teachers, corporate managers among others find them useful because they:

facilitate meaningful learning; the creation of knowledge frameworks that permit utilization of new knowledge in different contexts; and, the retention of knowledge over long periods of time (Novak 1998).

Young children are very competent at learning new concepts and can learn very quickly how to make good cmaps since they haven't been exposed to years of rote learning yet (Novak and Wandersee, 1990 in Novak 1998). After age 3 conceptual learning is acquired by asking questions and getting clarifications through concrete and hands-on activities (Novak 1998). While playing, children learn complicated concepts (Vygotsky 1978 in Owocki 1999) and represent meanings with spoken, enactive, iconic and symbolic representations (Brunner 1968 in Brooks & Dowley 1990). They have no fear of exploring unknown territories, such as manipulating software and equipment designed out of their age range. When using computers, they feel empowered and in control, enjoy making things happen, collaborating with peers, and using a wide-range of input and output devices (Clement & Nastasi 1993 in Clements 1997, Hakansson 1990).

Despite younger children's predisposition towards learning, the skills required to make concept maps are still in development. Awareness of concept acquisition, knowledge organization and self-regulation are skills that enable older children and adults to create and classify known and new concepts to make concept maps. 3-to-5 year olds have short attention spans; and, in consequence, concentration-related activities need to be organized in short periods of time. Young children can only organize knowledge voluntarily in structured learning environments supervised by teachers or caregivers (Bjorklund & Douglas in Cowan 1997). They learn by rehearsal, repetition and trial and error (Bransford et al 2000, Novak 1998). These skills can grow as a result of working with concept mapping activities that promote meaningful learning.

Preschool teachers use concept maps with children to stimulate thinking processes, the organization of learning experiences, and/or topic discussions. Through language and guided conversations with teachers, young children represent concepts with drawings as well as objects; and employ threads (as connecting lines) for establishing the relationships between them - Figure 1a. Despite teachers' efforts in adapting the cmap structure for use with children and the success stories they have reported (Mancinelli et al, Ali Arroyo, Figuereido et al in Cañas et al 2004), preschoolers cannot fully represent in the cmap the thinking process happening in their mind with the tools they use to communicate meaning. Figure 1a is a cmap describing "the life cycle of a pumpkin" created by 5 year olds (Mancinelli et al in Cañas et al 2004) illustrating the problem. They cannot write linking words (e.g. "to get", "is", "have"), or label the drawings with words representing concepts (pumpkin, broken pumpkin). Therefore teachers must use diaries or add written descriptions to the cmaps to record the meaning of the relationships established. The maps are not explicit: every person studying the structure will interpret them differently. This defeats two important characteristics of concept mapping: knowledge preservation and sharing. Critically, linking words, the elements that represent the nature of the relationship between concepts, are missing from the structure of these maps (Novak 1998, Coffey et al 2003).

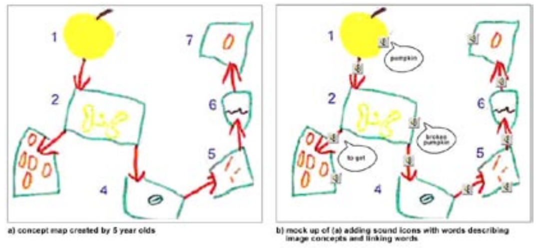

Figure 1: concept map describing the life cycle of a pumpkin

The envisaged tool would enable children to represent and label concepts and linking words (key elements of cmaps) by using images and sounds, as illustrated by mockup in figure 1b above. The software would allow images and sounds to be imported and/or recorded. To support navigation and interactivity for the child, software features should use age-appropriate iconic representations. The software would allow cmaps to be printed or saved. Teachers, who already use cmaps in the preschool classroom, may find these features useful in analyzing changes in children's conceptual processes throughout a topic of study.

The tool's GUI design should use a metaphor that assists children in the process of concept map making, facilitating this way meaningful learning. Concept mapping is consider a demanding mental exercise, therefore the software constraints and affordances should help children to keep their attention on the task, and handle interactions that can distract or confuse the users, such mouse behaviors. The environment should also provide engaging actions; direct manipulation devices; and include familiar audiovisual hints that guide the child during the activity (Hakansson 1990, Norman 1999).

Future work involves establishing a first draft of the design specifications using user-centered design principles. Commercial software such KidPix (movie editor) and Kidspiration (concept mapping software for 5 years +) will also be used as a field study tool to analyze children's interactions and potential requirements of the tool. The specifications draft will then be re-written with the information obtained from the study taking into account feedback and advice from early childhood practitioners involved in the project.

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Populating an Interface:

An exploration of designer perspectives on the use of static humanoid representations in interactive educational multimedia for adults

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Research Questions

Overarching question: What do designers consider as they develop static humanoid representations (SHRs) for interactive educational multimedia for adults?

Supporting questions: What do designers perceive to be the functions of SHRs in interactive educational multimedia for adult learners? What factors affect the design of SHRs in interactive educational multimedia for adult learners? (In terms of the development environment and its processes, and in terms of developing any particular representation and the details of its appearance.) What impact is intended for learning and learners when SHRs are employed in interactive educational multimedia for adult learners?

In other words: I'm interested in the use and development of (still) pictures of human/humanoid (faces, bodies, body-language etc.) for use in educational computer-based interfaces. Such representations might be in comic or photo form, and realistic or not. I'm wondering: Why do designers use them and what do they think they will achieve... How they come to any specific representation... (What role is played by stereotypes, political correctness, team politics etc. etc.) And more. It is a mixture of process, purpose and choices made along the way. Importantly, it is also using a particular interface artefact to illuminate negotiations between educational and visual designers.

Motives, Clarifications

The basic interest springs from my work as an educational designer making interactive educational 'products'. I have a feeling that (simple) human representations can have positive effect in terms of attraction and engagement of adults... when used artfully.

I'm not into AI or the complexity of conversational and/or animated agents. I'm not talking about avatars. Rather, I'm currently thinking of simple human-like characters (or sometimes even less complex things, like a human hand) when used in the stated context. These are a subset among a range of what might be labelled 'markers of human presence'... or 'visual humanising elements'. And I'm interested in the developer mindset surrounding them and the processes through which such ideas are developed.

Figure 1: The Little Guy or 'Helper' from OnSite!

Figure 2: Two views of the Traveller from an early version of Academic Writing

Figure 3: The Training Manager from TIP

Status/method

This research is currently at 'pre-proposal' stage and I am well aware that my terminology and my plan are currently a little 'loose'. From the examples shown above, you may deduce that I'm interested in looking at both interface/navigational elements and at content elements in web/multimedia products employing this static humanoid representation 'device'.

Briefly, I will develop a model of the 'space' of interest, in a generally qualitative research mode, through:

- selection of a range of relevant cases, assisted by expert nominations
- review of chose n range of educational multimedia artefacts
- perusal of any existing development documentation
- loosely structured interview with the artefacts' creators
- mapping development process (particularly in relation to humanoid element)
- identifying rationale and design detail decisions and collating across cases
- rechecking observations with creators
- creation of a coherent 'picture' (model)

Literature Links

This research is informed by a range of sources. The following are a starting point only:

Laurel (1990) contributes ideas on positive uses of 'anthropomorphic interfaces' in a range of applications. Note that such interfaces, however, do not have to implement the idea visually;

Oren et al. (1990) recounts development of an educational product using visual 'guides', touching on the impact of particular representation types chosen, and signalling potential issues in relation to more realistic 'characters';

Maes (1994) describes an agent system which shows its status via a simple comic face. Koda and Maes (1996) look closer at 'agents with faces' and the impact of such personification.

Wills et al. (1997) talks of 'humanising' an interface, a major part of which appears to be choosing good visual character representations of guides to assist interaction with resources;

Baylor and associates (http://ritl.fsu.edu) apply the evolving idea of 'embodied conversational agents' in education under a banner of 'pedagogical agents'. Though referring to animated representations, many factors considered (e.g. roles for and the manner of their agents' physical representation) are highly relevant to this study. (See Baylor and Kim (2004)); and finally,

DiSalvo and Gemperle (2003) discuss the use of human physical representation in design in general, providing support for thoughts on why such 'packaging' might 'work'.

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