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USER-CENTRED DESIGN: THE HOME USE CHALLENGE

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Abstract: Numerous techniques exist for ensuring the usability of information and communication technology for use at work, but will these techniques be applicable in the very different context of home use? This paper reviews the techniques that are now routinely used in the design of technology for the office to identify a new research agenda to facilitate good design of information and communication technology in the home.

Key words: standards, style guides, user-centred design, human-computer interaction, leisure, home use

1. STANDARDS AND GUIDELINES FOR LOW LEVEL DESIGN

Human-Computer Interaction (HCI) is a discipline concerned with the design of technological artefacts that are effective, efficient and satisfying to use. In short, HCI takes a user-centred approach to design. Its beginnings in the late 1970s and early 1980s came about through an alliance between Computer Scientists and Psychologists. Since then Ethnography, Ergonomics and Activity Theory have been recruited to the cause[14]. This first section of the paper describes some of the many techniques now routinely used to ensure usability in a product starting with the standards and guidelines devised to ensure good low level design. These techniques have evolved for use in work contexts, mainly PCs in the office. Their applicability for the design of products for use in the home is examined and areas where more research is needed are identified. The next section repeats this exercise for the processes and methods used to ensure good practice in user-centred design. Finally, some suggestions are made about how to progress the issues this analysis raises.

1.1 Standards

Table 1 lists the parts of the international standard ISO 9241. Those marked IS/EN are fully agreed international standards and the European

Norm. Those marked FDIS are in final draft from and are currently being voted on for adoption. Parts 1 to 9 are broadly ergonomic but parts 10 to 17 are directly concerned with HCI design.

Table 1. ISO 9241 Ergonomics requirements for office work with visual display terminals (VDTs)

Part 1 General Introduction IS/EN
Part 2 Guidance on task requirements IS/EN
Part 3 Visual display requirements IS/EN
Part 4 Keyboard requirements IS/EN
Part 5 Workstation layout and postural requirements IS/EN
Part 6 Environmental requirements FDIS
Part 7 Display requirements with reflections IS/EN
Part 8 Requirements for displayed colours IS/EN
Part 9 Requirements for non-keyboard input devices FDIS
Part 10 Dialogue principles IS/EN
Part 11 Guidance on usability specification and measures IS/EN
Part 12 Presentation of information IS/EN
Part 13 User guidance IS/EN
Part 14 Menu dialogues IS/EN
Part 15 Command dialogues IS/EN
Part 16 Direct manipulation dialogues IS/EN
Part 17 Form filling dialogues IS/EN

An international standard has the weight of law behind it but perhaps a more commonly used form of standard is the "style guide". This rather misleading term is taken to mean a set of guidelines describing how a graphical user interface should work, for example, what a dialogue box should look like, how it should behave when the user interacts with it and when it should be used rather than some other device such as a menu. Apple produced the first style guide in 1987 [1, 2]. Style guides encapsulate a great deal of empirical and analytic work carried out by HCI researchers to find out what actually was the best way of doing things. There are now style guides for all the commonly used graphical user interfaces, e.g.,[12]. Style guides are supported by software tools. Thus a software developer using a programming tool such as Visual Basic will find it much easier to obey the style guide than to ignore it and develop idiosyncratic interfaces that do not behave in the way users are used to. By enforcing a degree of consistency in this way, style guides ensure that when a user learns to do something in one context that knowledge will transfer to new contexts in a sensible way.

Will ISO 9241 and style guides for graphical user interfaces be applicable to products for use in the home? If the product is PC-based the answer is probably yes. There is a lot of sense in making sure that the PC someone uses in the home works in the same way as the one they use in the office. However, PCs are expensive. The mass market penetration of information and communication technology in the home depends on the development of new cheaper and less general purpose devices based around the TV, mobile technology and information appliances. These new user interfaces present quite a different challenges to usability due to their size, input requirements and context of use. The standards described above quickly loose their meaning when there is no keyboard, mouse or high resolution screen. Thus the first element in our research agenda is: (A) the development of style guides and standards for these new forms of human-computer interface. To be effective they need to be developed in parallel with the hardware they support. In this way, the research on the best way to use a particular technology can inform the development of that technology and vice versa. Interestingly, ISO are working on a more general standard for multimedia user interface design (ISO 14915) though this is at a very much more preliminary stage than ISO 9241.

1.2 Principles

Early work on the effective use of graphical user interfaces was concerned with establishing higher level principles for good use interface design see for example [11]. These principles are the basis of the more detailed style guides and are often re-iterated in them. Take for example the principle of "reversibility". One of the problems users had with early interactive systems was that they did not encourage exploration. Carroll and Carrithers [4] describe how users might spend several minutes recovering from the wrong choice in a menu. To avoid this, style guides prescribe a variety of devices for undoing the unwanted effects of actions taken by a user, e.g.: the "back" button in a web browser; the "cancel" button in a dialogue box or the "undo" function in a word processor. All these features follow the principle that the effect of any action that a user takes should be reversible. Users should be able to take this as given and where it is simply not possible the user should warned before they take the action in the first place.

Another valuable principle that has been analysed in some depth is action-effect consistency. This states that if the user takes some low level action it should have the same effect whatever the context. For example, pressing the delete key or clicking with the mouse should have the same effect whether one is editing a file name in a dialogue box or editing the text in a document. Another way of expressing this principle is to say that interfaces should be "mode free". Of course, very few user interfaces are

completely mode free. To take a familiar example, entering text into a word processor has different effects depending on where the insertion cursor is. Normally, the letter typed appears immediately to the right of the last letter typed. When the insertion cursor get to the right margin a more complex algorithm comes into play to decide when and how many characters should be carried to the start of the next line. This change in mode is not a problem until one is attempting some intricate formatting job such as tabulation when it can be frustrating and confusing, especially for beginners. Given the inevitability of some degree of "modedness" research has concentrated on identifying when modes are a problem and how mode changes should be signalled to the user [10].

Principles concerned with consistency in one form and another have been a recurring theme in HCI. "Task-action consistency" [17] is an attempt to optimise the relationship between a users view of the task they are trying to complete, e.g., drawing a square, and the set of actions they need to take in order to complete that task. People expect tasks that they view as similar to require similar actions. Thus the actions required to draw a square must be consistent with the actions required to draw a circle.

A new consistency problem has arisen through the use of different devices that may be used to access the same data in home use. Thus someone might access their bank account: via the buttons on a mobile phone or PDA; by speech over a conventional telephone; using a hole-in-the wall automatic teller in the high street, or via a PC and a web browser. Action-effect and task-action consistency no longer apply as the actions taken are so different in each case, yet one still needs to portray a consistent system image and make it possible for people transfer knowledge gained using one device to another. Thus someone who normally uses a PC to access their bank account should feel the application is familiar when they access the same functions via a speech interface. They should also be able to use knowledge they have gained navigating the PC interface to navigate the speech interface. This is the second element of our research agenda then: (B) what principles can be devised for accessing the same data and functions from multiple heterogeneous devices?

2. Processes and methods for ensuring effective user centred design

There is general agreement on the processes needed to ensure effective user-centred design. This can be seen in the international standard ISO 13407 ("Human-centred design processes for interactive systems"), HCI text books [7, 18] and in published methodologies such as Contextual Design [3] and Monk's Light Weight Techniques [13, 15]. These common elements are illustrated in Table 2.

Many computer systems come to grief because they are not designed to perform the right functions and so it is important to get human factors input into the earliest stages of requirements analysis. The first two processes depicted in Table 2 are concerned with understanding the work context and the work to be supported. Understanding the work context involves identifying all the stakeholders and their concerns. Computer systems change the way people work, otherwise there would be no point in introducing them. It is thus possible to provide a system that supports one person's work very well while having side effects on the way work is done that make another person's work difficult or even impossible. Only by identifying all the people that could possible be affected by the introduction of the new system and their particular concerns, is it possible to avoid this kind of problem.

Table 2. Common processes in user centred design

Understanding the work context

Methods: focus groups, interviews, observation

Representations: the rich picture

Problems in the home domain: people are not practised at articulating what they do at home or why they do it.

Understanding the work

Methods: focus groups, interviews, observation

Representations: HTA, WOD and exceptions, scenarios

Problems in the home domain: as above, and what is the equivalent of a task?

Testing a top level design against your understanding of the work

Methods: Scenario walkthrough, Cognitive Walk Through

Representations: Story boards, dialogue modelling

Problems in the home domain: what is the equivalent of a task?

User testing of more detailed prototypes

Methods: Usability Labs., Cooperative Evaluation

Representations: Paper prototypes, simulations

Problems in the home domain: what is the task to be set?

Once the design team has gained a broad picture of the work context they can focus on the particular work to be supported by the computer system. As with the work context, the data used to do this will come from interviews and observation in the work place. Typically some sort of representation will be used to record and reason about the way the work proceeds. The two most commonly used being Hierarchical Task Analysis [20] and scenarios [5]. A scenario is simply a story that takes the reader through the steps taken to perform a work task described at a fairly high level. It should include details obtained from the analysis of the work context such as interruptions and parallel tasks not to be supported by the computer. In general several scenarios will be needed to cover the most important variations in the way work may be completed.

The next step is to build a model of the high level structure of the user interface. This will omit many details of screen design but will describe how a user moves from one task to another. This "dialogue model" [13] can be evaluated against the representation of the work to be supported. For example one can go through the scenarios checking that all the work tasks can be completed and that the way the operator has to work is efficient and fits in with the larger job.

Finally, a detailed prototype of the user interface is built and tested with real users. Much can be done at early stages using mock-ups or paper prototypes before any code has been written [15]. There are also usability inspection techniques that can be applied to a user interface specification [16]. In this way one can ensure that the user interface will communicate the designer's intention to the user effectively.

What then are the problems in applying these techniques in the home? Can we directly transfer the techniques developed for understanding a work context into techniques for understanding the home context or techniques for describing work into techniques for describing what people do in the home. There are two related problems with this. At work we often have to describe to other people what we do or what we have done, thus we are all well practised at thinking about and describing work tasks. In the home this is not the case, yet the data needed to perform the first two processes in Table 2 depend on this ability. It is not clear that interviews with family members will be effective in eliciting the detailed information needed to design products that fit in with the way people want to behave at home. The other option is direct observation of people in their homes. Here again there are problems as people are generally less willing to have strangers observe them in their homes than in their workplace. Perhaps because we don't spend much time thinking about or describing to others what we are doing in the home, there is also less agreement about how to describe what happens there. Some of what we do in the home is very much like work and may be described as productive (e.g., cleaning or shopping) or personal maintenance (e.g., sleeping, eating and grooming) [19]. Other activities, however, have no obvious purpose, they are "leisure activities". What are the "tasks" involved in reading a novel or watching TV? Even when we are doing work-like tasks at home our motivation and concerns may be quite different from when we are at work being paid to do something.

When it comes to the third and fourth process described in Figure 2 similar problems arise. If we can't describe the activity we are doing and our motivation for doing it how can we evaluate a prototype design against such a description?

These are then the next elements in our research agenda: (C) how can we adapt old techniques and develop new ones to understand what people do at home and why? (D) what is the equivalent of "task" in a leisure context; (E)

how can user testing techniques be adapted for use in the home? All these agenda point to basic lack of concepts for thinking about leisure and home use. This problem and some promising ideas are discussed in the next section.

3. THINKING ABOUT HOME AND LEISURE USE

Table 3 gathers together the research agenda identified in sections 1 and 2. (A) and (B) are not specific to the home-use context though they are clearly more salient in the home than at work. Analytic studies drawing on interaction concepts developed in GUI environments will provide some guidance in this area of low level interaction design. The other source of information needed to complete these elements of the research agenda will come from the experiences of researchers and early adopters with the first products. HCI research is inevitably one step behind the technology when major new inventions come along because they change the way users behave and what they want to do. Carroll and Rosson [5] call this the task-artefact cycle. Invention makes possible new ways of doing things, that make possible new inventions, that make possible new ways of doing things, and so on.

Table 3. The research agenda

(A) the development of style guides and standards for new forms of human-computer interface
(B) principles for accessing the same data and functions from multiple heterogeneous devices
(C) new techniques to understand what people do at home and why
(D) finding the equivalent of "task" in a leisure context
(E) how can user testing techniques be adapted for use in the home?

(C), (D) and (E) will similarly come from the experience of applying current techniques in the home. All the major industrial players are putting considerable effort into trying to understand the home context through ethnographic studies and trials and some interesting concepts are emerging, some of these are listed below.

Personalisation: a personalised interface knows things about you. It knows your preferences. You may have customised it to make some things easier to do or more salient. You may have changed the appearance of the product by decorating it in some way. It also knows about your previous history with it. On the basis of this history it may be able to suggest new things for you to do.

Tangibility: a tangible interface uses familiar objects in new ways. Thus Lego bricks may have computing power, a ping pong table may react to the ball hitting it or the movements of a toddler in a bed of coloured balls may be sensed to provide an interactive musical experience.

Aesthetics: have an important part to play in selling products of all kinds, also in the enjoyment with which a product is used. Aesthetics will be particularly important when people have to pay to use a product, rather than being paid to use them, as in the work context.

The above concepts apply to the products themselves, the subsequent ones apply to the uses we put to them.

Engagement: one of the motivations for taking part in leisure activities is simply to become fully engaged in the activity. Csikszentmihalyi [6] describes the conditions necessary for a "flow" experience. These are that the activity should have clear goals and good feedback as to whether they are being achieved. Also that the difficulty of the task should closely match the ability of the user. While the intense experiences described by Csikszentmihalyi are unlikely to be the norm outside of computer game playing, this work clearly has some important things to say about home use.

Socialising much of our leisure activities involve socialising with friends and family. Understanding the conditions that make socialising a good or a bad experience will be crucial in the design of these systems.

4. CONCLUSIONS

While many of the concepts and methods developed in the work context will transfer to home use there is still a lot research to do before we gain the same level of understanding that is reflected in current standards and methods for designing graphical user interfaces for office products. In particular, we are lacking basic concepts equivalent to "ease of use", "ease-of-learning" and "task fit", i.e., what is fun and how may we deconstruct it?

It took ten years to get from the first papers describing the problem of designing interactive systems for the work place (see for example [8]) to the first papers describing key concepts and methods (see for example [9]). It took further 10 years for the area to mature to the extent there was sufficient consensus for clear standards to emerge. The development of HCI for home use will be much swifter. It is no longer hard to convince the people that count that HCI issues are crucial to the success of product in this area. We have an exciting time to come.

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