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# User-Centred Design of Smart Internet Technologies: A Best Practice Guide for the Discovery Phase of the Design Process

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# 1 Overview

This best practice guide presents a user-centred approach to the discovery phase of the design of Smart Internet Technologies (SITs). This guide is distinctive in that it focuses on the discovery of new technologies within universities working with corporations, prior to the development and commercialisation stages of design. The discovery phase lies before the integrated product development phase. The university presents a different culture to that of the corporation with performance criteria based on the discovery of knowledge as evaluated by peers. The focus is less on use and usability than in the corporation. Hence the user-centred design (UCD) approach in the discovery phase of design in a mixed university and corporate environment, has to emphasise even more the shift from a perspective based on one discipline to a multi-disciplinary one.

The guide does three things. First, it details the costs and benefits of user-centred design in software development and commercialisation. Second, the guide examines the value of user studies, personas, scenarios and *visioneering* as ways of focusing the development of software on users' needs in the present and the future. Third, it discusses the interaction of the UCD and project teams.

This best practice guide draws on the experience of user centred design, particularly in the Smart Personal Assistant (SPA) program of the Smart Internet Technology Co-operative Research Centre (SITCRC). The guide places this experience within the literatures on usability and user-centred design, human computer interaction, and the sociology of technology and communication.

The methodology will evolve as the interaction between people from the User Needs (UN) project and the technology programs intensifies and lengthens.

# 2 Measurable benefits of user-centred design

User-centred design places users and their activities at the center, at all stages of the design process. Users' activities are examined within their social and cultural context to see how new technologies can fit with accepted ways of doing things. In the process new technologies can also change the way the activity is conducted.

This user-centred approach has been conceived as usability, interaction design, computer-human interaction and human-computer interaction. The approaches sometimes refer to a process of design and sometimes the users' experience of the product or service.[1] The best known texts of these approaches are Jakob Nielsen, Donald Norman, John Seely Brown, Dertouzos and Vredenburg. (Brown and Duguid 2000; Dertouzos 2001; Nielsen 2000; Norman 1990; Vredenburg, Isensee et al. 2002)

There are measurable benefits in connecting the perspectives of the technologists with those of users. These benefits include increased sales, reduced development time, time saved on redesign, reducing the costs of help desks, and user productivity and satisfaction. A usability expert who has worked with 40-50 companies on designing software has never seen a software project that has used the usability approach, fail.[2] The benefits are particularly great at the early processes of design, where users are studied within their social and cultural environments. As Mayhew (2001) says, "Finding out prior to design what the unique requirements are, and designing to support them, is much more cost-effective in the long run than finding out after launch that your design does not meet requirements."

We present quantifiable benefits of UCD below:

- Software industry studies suggest that an investment in usability engineering can produce a return on investment in the range of 3:1 to 100:1 (Karat, 1990)
- Experience of ten years of usability projects shows that a ten per cent investment in usability increases user benefits from 100 to 180 per cent (Nielsen, 2002)
- Usability engineering has demonstrated reductions in the product-development cycle by over 33-50 per cent. Sixty three per cent of all software projects over run their budgetary estimates, with the top four reasons all related to unforeseen usability problems (Rhodes, 2001)
- Design changes due to usability work at IBM resulted in an average reduction of 9.6 minutes per task, with projected internal savings at IBM of $6.8 Million in 1991 alone (Karat, 1990).
- It costs 100 times more to change products that are already in the market than change products and services before code is written (Nielsen, 2002).
- Help desk calls are estimated to cost between $US30-$US100 a call, depending on the complexity of the software. More than half the calls are due to poor usability. (Nielsen 2000)
- Eighty per cent of maintenance is due to unmet or unforeseen user requirements; only 20 per cent is due to bugs or reliability problems (Rhodes, 2001).

The benefits of the user-centred approach are so demonstrable that corporations such as IBM, Apple and Oracle have adopted UCD as an integral part of product design. At Oracle, 60 per cent of the user-centred work is done at the very initial stages of the project (Rosenberg and Kowalski, 2002).

[1] Personal communication, Jakob Nielsen, 21 June 2002, Sydney

[2] Personal communication, Bruce Tognazzini, 21 June 2002, Sydney

# 3 User-centred design at the discovery phase of design

Traditional ways of designing software focus on the technology to ensure that "it works". After a prototype is developed, it may go through some usability processes at the later stages of design. We are recommending that the user-centred design process start at the earliest stages of project formulation. This early adoption of UCD will ensure that we:

- Identify the potential users of the technology so that the technology is designed for a range of users from the very beginning;
- Identify routine tasks that can be facilitated within a broader consideration of the activity area;
- Take care that the use of the proposed technology fits into accepted ways and meanings of conducting the activity within different environments;
- Try and project to future users and uses of the technology.

These questions can best be addressed together by members of the project and UCD teams. Both teams need to begin thinking outside their traditional boxes. The process of connection is helped by user studies, personas, scenarios and *visioneering*. These can be ways of focusing the development of software on users' needs in the present and the future.

## 3.1 User studies

User studies focus on users, their activities and their social and cultural context. Most often the studies use a combination of qualitative and quantitative approaches. These user studies may be found in sociological studies of technology and the diffusion of innovations. Studies that detail aspects of a product design include the ethnographic approach of observing users' environment. Focus groups and lab observation are also important.

An important question is "Who are the users?" This is particularly important for software design where many projects do not detail the potential users of the product. Our study of academic computer scientists designing SPAs (Singh and Satchell, 2002) shows that the dimension of use is not valued in the more theoretical streams of computer science. New technologies are valued above those that are more useful. In the absence of overt attention to users, the implicit user can often be in the image of the academic computer scientist - male, in their 30s or 40s, expert computer user with access to an office. This self construct of the user is recognised as a common feature in technological design (Vredenburg, Isensee et al. 2002). It is equally important to note that computer scientists often do not use the software they design (Cooper 1999).

There are two advantages to listing the users. The first is that there are valuable insights in sociological and anthropological studies from the users' perspective of different user groups. They enable the group to place the user at the centre, focusing on activities in their social and cultural contexts. The second advantage is that it can become apparent that the technology being proposed may have uses beyond the limited context being examined. For instance, an e-mail agent which can sort mail and draft replies is not only useful for academics, but may save time and energy for people dealing with customer relations in small and medium enterprises and corporations.

Studying the issue from the users' perspective focuses on how people conduct activities within their social and cultural context. The user is at the centre rather than the technology. The question then is one of how the new technology may fit in with the mix of other technologies already in use and familiar ways of doing things (Singh 2001). Examples of user studies are Silverstone and Haddon's studies of the use of information and communication technologies (ICTs) in homes in the United Kingdom (Silverstone and Haddon 1996) and Australian studies of the use of ICTs in the home, small business, governments and corporate environments (Singh, 1999, 2001; Singh and Ryan, 2000; Singh and Slegers, 1998).

Such studies are particularly important when the new technology has to fit with other new and old technologies. A failure to keep the environment in mind has led to design disasters like the home theatre (Norman 2002), where one new technology does not fit easily with another part of the system. The users' context is particularly important to prevent over-estimating the importance of technology. Bruce Schneier's 2000 book is a *mea culpa* that in highlighting the role of cryptography in security, he overlooked the context of the user. Assuming that mathematics would provide the answer, he failed to understand in his earlier work that "the fundamental problems in security are no longer about technology; they're about how to use the technology" (Schneier 2000: 398).

The goal of user-centred design is to increase user productivity and satisfaction. Studies of the adoption and use of technologies have shown that for technologies to be successful they need to have the following criteria:

- They need to be easy to use;
- They should provide relative value – in terms of cost, convenience, mix of channels or better ways of conducting the activity;
- A person can try the technology or observe it before committing to it;
- Technologies have acceptable social and cultural meanings;
- People trust the technologies ( See Newstead 2000; Rogers 1995).

## 3.2 Personas and scenarios

A shift from the technical to the users' perspective is difficult to achieve. This is particularly true at the beginning of a project when the issues are complex and ambiguous. Stories are able to express this complexity and are good communication tools. They give an occasion for reflection at the beginning and intermediate phases of design. They keep the design focused on the user, his or her goals, activities and social setting. The stories keep the design fluid and flexible and yet present something concrete. And most importantly, stories use language users can understand (Carroll 1995).

The stories we tell change in complexity as the questions change from describing the users and their environments to understanding the tasks that may be automated or facilitated.

The first step is fleshing out the personas, that is the characters in the story. Personas represent the ideal type of different kinds of users. These personas are based on existing user studies, where possible. The personas are best developed in meetings of the UCD team, drawing on experience from different perspectives. In our work at the SITCRC, we have also used expert panels, focus groups and open-ended interviews to check the validity of our personas.

Cooper's study has been the most helpful in guiding the development of personas (Cooper 1999). He suggests that a project have three to 12 personas – some being central to the design, and others being marginal. Each persona is given a name, a photograph, an environment, a description of expertise and personal and practical goals. Personal goals are particularly important for design. These goals do not change as fast as tasks. Personas are specific rather than elastic. The thumbnail sketches of personas need to be placed before the product and design team so that the design can constantly refer back to personas and their goals.

The scenarios give the detailed plot of the story, starting with one to three daily activities. It is the scenarios that provide a basis for specifying the tasks that SITs can automate or facilitate. For instance, in order to manage e-mail, a person has to undertake a number of tasks:

- Opening the e-mail program
- Browsing through e-mails in the in-box
- Prioritising response
- Responding within an acceptable period
- Noting tasks generated by e-mails
- Deleting e-mails
- Filing e-mails in folders
- Searching e-mails to recover the conversation thread.

It is some of these tasks that the SITs will be addressing.

We found that the complexity and intent of scenarios change according to the stage of the project. At the beginning, when we need to persuade the computer scientists to try a different process of design, the persona with a short scenario of one or two every day tasks is adequate. When the design of the technology is underway, then a more detailed task oriented scenario is more appropriate.

## 3.3 Visioneering

Visioneering is a way of thinking about the future and future users, in a way that is not constrained by our present.[3] This exercise ensures that we are thinking of, rather than predicting, the future.

To think forward ten years, the thinking needs to focus on changes in cultural and social institutions. In the medium term, say three years, most often we move from an identification of trends from different perspectives. These trends could be the ones most frequently identified, such as a speedier Internet, more personalisation, using voice to direct the computer. The trends could also be in particular domains such as government electronic service delivery, customer service or media.

Visioneering is a team effort involving members of the product and UCD teams. The group should ideally be between 10 and 15 people. Ideally the workshop needs to go over two days, starting from the long term future, and moving to the one year horizon. The workshop needs to based on prior thinking. This then leads to identifying social and cultural changes and technological trends over the next three years.

[3] This section is based on a workshop by Jakob Nielsen and Bruce Tognazzini in Sydney on June 21, 2002.

At the workshop, each person presents to the group for ten minutes using transparencies. The next stage is to vote to rank the different trends. Smaller groups of three to five people then work on the voted three best trends and applications, drawing on user data. The group have to be able to present a picture of the new application.

The next day is taken with integrating elements of the three designs for a one-year horizon. The group makes a prototype. The emphasis here is to have something concrete to which people can react, rather than a prototype that is high tech.

After the two-day workshop, the prototype is tested with users and the project is planned.

# 4. Communication between the project and UCD teams

The UCD process depends on establishing a comfortable meeting place for effective, sustained communication during all phases of the design process, between UCD researchers and the computer scientists and engineers in the project team. Communication is often the most important challenge in a multi-disciplinary project. "Seeing differently" and being comfortable with a plurality of stories and languages requires sustained work (Brown 1997). A failure to nurture cross-disciplinary perspectives is often the reason why UCD processes falter in the technology programs.

This ability to see differently is particularly important because UCD aims to change the traditional approach focused on technology and components. Traditionally the approach is to develop the product before validating it with users, aiming to limit the defects. The project team is concentrated in one discipline and has no specialisation in user experience or measuring it (Vredenburg et al. 2002). The UCD approach has the user at the centre focusing on activities in their social and cultural contexts. An important part of the UCD work is done before the design is implemented. It is multidisciplinary and focuses on the user experience.

I will use my interaction with members of the SPA program in 2001 and early 2002 to illustrate how some of the successes were achieved and where the process faltered, and draw out the do's and don'ts for effective communication.

## 4.1 The SPA case study

### 4.1.1 A good start

We started well with a face-to-face residential workshop in early 2001 involving people from all parts of SITCRC to establish relationship. The researchers came from all parts of Australia.

I came away from the workshop having ironed out some of the basics of communicating with computer scientists – use PDF and not word even for draft documents. It was comforting to know people's personal histories – to know who had come from philosophy, who had come from theology, and who liked reading Isaac Singer. After this face-to-face communication, it was easier to talk on e-mail and ensure that we articulated the users and their activities in social and cultural contexts.

Subsequent SPA program workshops made it clear that the computer engineers had designed the project with themselves in mind. The computer scientists and I agreed it would be valuable to make the implicit user construct more overt. Hence the UN researchers began a study of academic computer scientists and how they managed information and communication. It was in this context that we asked whether they would or would not use SPAs (Singh and Satchell, 2002).

The SPA user study proposal was important in that it meant the SPA group included UN researchers, together with quarterly travel and accommodation costs for regular meetings, in their budget.

The user study was also important in that the UCD team – at the time it included me (a sociologist) and one graduate student (media studies) – conduct open-ended interviews with academic computer scientists in Sydney and Melbourne.

The study led to insights about the ways in which academic computer scientists connect or do not connect use and design. More importantly, the interviews led to the technologists reflecting on how they managed information and communication. The study also helped the dialogue between the UN team and the technologists.

My review of SPA literature from the users' perspective also helped. I could follow the jargon within their frameworks to a greater extent than before.

At a further workshop towards the end of 2001, the SPA team leader invited me to present personas as a way of moving people to thinking of users and their activities in their social and cultural context. Telling short stories was a good way of getting the attention of computer engineers – particularly those who thought that we should not waste time on ancillary tasks and just get on with designing something that "works" at the level of code.

### 4.1.2 Communication falters and then stops

A workshop in February 2002 to discuss a new round of projects incorporated some of the personas and scenarios to a varying degree. However the researchers proposing the projects did not have any prior discussion with the UN researchers. In part there was a feeling that computer scientists have previously worked with scenarios. Having included personas and scenarios, it was as if they had structured a UCD perspective in their project. This lack of interaction meant that in that round of projects, no UCD researchers were included in the SPA budget.

Just after this round of projects, there were changes within the SPA group. One of the results of the changes and the uncertainties meant that the teleconferences and the workshops did not happen. There was no one point of contact in the SPA group. The computer engineers' main priority was now to get a deliverable by the end of June 2002. At the same time that these changes were happening in the SPA group, it was announced that my research centre in Melbourne was to close. This meant that we were not able to work up more detailed scenarios or evaluate the progress of the design against what was known about the activity and the users.

Towards the end of June, I sought the opportunity to touch base with the new project leader. I found an e-mail agent had been devised to sort e-mails and draft replies on some e-mail programs. It was limited but impressive. What was interesting, is that the researchers were now seeing possibilities of use in corporate and business environments to deal with customer response. We had not identified this use outside the academic environment at the beginning of the project.

The new project being proposed by the SPA group carries this research further. They are thinking in terms of UCD, but only for user testing after the agent had been designed. Being in Sydney and having seen the demo, I suggested that the UCD team could help with user studies, personas and scenarios at the initial stages of the design. More importantly, to have a role in the project, we needed to be included in the SPA budget.

## 4.2 Essential steps for good communication

The SPA case study shows that in the discovery stage of the design of technologies in a university, it is important to note that:

- The research organisation needs to flag the importance of UCD. SITCRC has users at the centre of its technological design.This principle is the distinguishing characteristic of SITCRC and resulted in the User Environment program being established, together with the four technology programs.
- It is crucial to win the confidence of the program leader and key researchers, showing how UCD can add value. A primary task is to begin a dialogue with the technologists, so that the expectations on both sides are clear.
- It is important to reach across to the technologists by doing user-focused studies in their area of expertise. This worked well in the SPA program, and we did the same thing with the Natural Adaptive User Interface and Intelligent Environment programs.
- It worked well to have the UCD researchers concentrate on their own group while interacting frequently with the project team. The centralisation of UCD researchers allowed for interaction to develop and to test the emerging methodology. This concentration of UCD was partly because UCD researchers were in Melbourne and SPA researchers were in Sydney.
- The centralised approach to UCD can only work if there is frequent communication between the UCD and project teams;
- Face-to-face communication was essential for the early stages of the project when understandings and trust had to be established. E-mail, teleconferencing and mailing lists were effective for up to three months, when face-to-face meetings again became necessary. We did not find video-conferencing an acceptable alternative because of the costs and problems of access.

## 4.3 Making communication better: Next steps

The SPA study shows that despite a hopeful start, communication faltered. As a result UCD processes were not followed at all stages of the design of the e-mail agent. UCD processes were not envisaged as part of the initial stages of the design of other SPA technologies which were at the centre of subsequent projects.

Drawing on the SPA study and literature, we found that:

- A research organisation needs to build its commitment to UCD through a quality assurance process. This process should ensure that UCD has been part of the project formulation, planning and execution of the design.
- Having UCD as part of a documented quality assurance process means that no project receives funding without budgeting for UCD processes at the beginning of the project.
- Having UCD as part of the discovery process means putting time and money aside for doing substantial user studies, persona and scenario construction and visioneering workshops. This should be done before coding begins and has to be factored into the design and funding of projects.
- On the UCD side we could have stressed more strongly the benefits of UCD in terms of project time and results. To do this we need to have in place evaluation that leads to quantifiable benefits through all stages of the project.

- We have found on the UCD side that the barriers to dialogue are not necessarily restricted to cross-disciplinary perspectives. Some of the barriers have to do with different conventions of e-mailing and different use of word processing software. Common words have different meanings across disciplines. Moreover there are different views of the "core" processes of the design of technologies. It is important to address these differences at the very begin to establish understandings.
- The literature suggests that the UCD team should be multi-disciplinary including sociologists, psychologists, graphic designers, usability engineers, writers. At the discovery stage, our emphasis was in getting included in the technology programs. But at further stages of design, we will need to deal with communication within the UCD team. A multi-disciplinary team has important funding implications.

This good practice guide will evolve as our engagement with the technology programs becomes more extensive and deepens. The focus will then move on reaping the benefits of early UCD at the discovery phase, to document its effects on project implementation and commercialisation.

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