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# Technology Culture of Mobile Maintenance Men

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## Abstract

Technology plays a major role in our life and the role is increasing as a result of fast technological development occurring all the time. Technology's impact on our everyday life sets new challenges also to designers. In order to design products which are usable. We need to understand technologies and devices we are developing, users of our designed products, and the relationships our users have with different kinds of technologies.

User-centred design (UCD) has emerged as a counter part for traditional technology centred product development. UCD emphasizes the role of the users in every phase of product design and development. However, it seems that the users' relationships with technologies is underestimated and sometimes even forgotten also in UCD. The users' current tools and technological environment is seen as just surroundings and task related tools instead of as an important factor that affects to users' actions and opinions.

This article presents a case study where mobile IT maintenance men where studied with traditional UCD methods and in addition the user research was deepened with focusing on users' relationships with technology. The results show that UCD's methods can miss some critical phenomena relating to users' relationships with technology and affecting to usability and quality of the developed products.

Understanding how users comprehend the technologies they use, i.e. understanding what kind of technology culture the users are a part of, enables designers to better evaluate how well the developed product will fit in the lives of it's users and what sorts of changes are possibly going to happen or required to happen in order the new product to be included in the users' technology culture. These kinds of evaluations help the designers to design better products and the companies to better estimate business risks relating to for example technology acceptance.

### Keywords

Technology Culture, User-Centred Design, User Research, Distributed and Mobile Work

We live in highly technologized world. Different technical devices and systems play a major role in our lives. The environment we operate in is for the most part human-built (Hughes, 2004). Actually, almost everything we do involve some sorts of relations to technology (Mackenzie and Wajcman, 1999).

In addition more and more technologies are introduced to all kinds of work and free-time settings constantly. At the same time technologies are

changing and developing rapidly. Recent trends have been among others convergence of especially ICT technologies (Elliot, Blood & Kraus, 2005), miniaturization of electronic components (Moore, 1965) resulting an increase in computing power, and increasing connectivity between both people and machines (Hollands, 2003).

Ever changing technologies result in challenges in understanding how the technologies work and what actually can be achieved by using them. A mobile phone is a good example of this phenomenon. During recent years the mobile phones have developed to a point where they can be used to almost all the same things as laptop computers. Actually some of the mobile phone manufacturers have even started to speak about business and multimedia devices[1] instead of mobile phones. Growing complexity of technologies and especially user interfaces, i.e. featurism or user interface bloat (McGrenere, Baeker, Booth, 2007), has complicated the devices and there probably are only few people who actually are able to use all the features of their smart phones, not to mention needing them all. Some technology trends (e.g. convergence) seem to also lead to situations where the utility of certain technical system or device is vague. The device is different for each of its users. Mobile phone is a good example of this trend too. Mobile phones can be just wireless phones, personal information managers, email clients, tools for getting Internet connection or all of them depending on the needs and expertise of the users. A modern smart phone is essentially same thing as a 10 years old mobile phone for users who only need and use call and perhaps SMS functionalities of the device.

Rapidly evolving technologies and their vast impact in our lives challenges the designers to design products and services that take into account both the manifold needs and varying capabilities of the users, and the evolving relationship that the users have with different technologies.

User-centred design (UCD) approach emerged as a response to system-centric design traditions (Mao, Vredenburg, Smith and Carey, 2005). UCD is a field of design that aims at producing a holistic understanding of potential users of designed service or product and utilizing the gathered knowledge in design (e.g. International Organization for Standardization. 1999). As a result a product or service that takes into account the needs, context, and insights of users should emerge. In other words, the aim is to design products that are easy, learnable, efficient, effective, and satisfactory to use, i.e. usable (Nielsen, 1993; International Organization for Standardization, 1996). The basic principles of UCD, early focus on users and tasks, empirical measurement, and iterative design, have remained quite the same from the Gould and Lewis's (1985) proposal and are now accepted as the basis of user-centred design (e.g. Mao et al. 2005).

Since UCD aims at doing design based on users' needs, context and personal characteristics, the gathering and building of holistic understanding of users is a key factor in UCD process. As a result a lot of different kinds of methods for

[1] http://press.nokia.com/PR/200504/991467_5.html and http://www.nokia.com/A4136001?newsid=1135216 (March 31st 2008)

gathering user information have been developed. The most common user research methods include interviews, (participatory) observations and questionnaires (e.g. Kuniavsky, 2003; Hackos and Redish, 1998). In addition to these also more creative methods and approaches such as cultural probes (Gaver, Dunne and Pacenti, 1999) and empathic design (Koskinen and Battarbee, 2003) have emerged. However the role of technology in users' lives seems to be often forgotten or underestimated in UCD.

This article presents a case study of mobile IT maintenance men. The maintenance men where studied and analyzed with traditional user research methods of UCD, namely interviews and observations, and also by giving extra attention to their relationships with technologies they use. The results of different research and analysis approaches are compared and suggestions on how to further develop UCD's user research are given.

## User-centred design and technological context

The changing technical surroundings of users mean that in order to truly gather holistic view of users, user-centred designers need to put special attention on understanding the technological context the users act in i.e. the systems and devices the users use. In practice this means that there is a need to understand deeply the devices and their user interfaces the users currently use and will use in future. This need has been widely recognized in UCD literacy (e.g. Hackos and Redish, 1998; Beyer and Holtzblatt, 1998). In addition of their centrality in people's daily lives, focusing on different tools and devices has been reported as a good strategy in situations where the users' working times or tasks are irregular (Dix, Ramduny, Rayson, Onditi, Sommerville and Mackenzie, 2003).

The traditional ways the user-centred designers take into account the users' current user interfaces resemblances to competitor analysis. The current tools are usually analyzed from the point of view of users' tasks keeping in mind that new products probably will make some or all current ones obsolete by providing better ways to do the tasks or by changing the tasks themselves. These kinds of analyses are usually called artifact analysis.(Hackos and Redish, 1998; Beyer and Holtzblatt, 1998)

Usually artifact analysis mean documenting the artifacts, i.e. tools and devices, the users use and using this information somehow during the product development (e.g. Raven & Flanders, 1996; Bauersfield & Halgren, 1996; Beyer & Holzblatt, 1998). For example Beyer and Holtzblatt (1998) describe artifact analysis method in which all artifacts users use during the observation periods are documented and an artifact model, which explains users' ways of organizing their duties, is then produced.

Interactive Feature Conceptualization (Bauersfield and Halgren, 1996) and Usability Roundtables (Butler and Tahir, 1996) emphasize artifacts a bit more. In Interactive Feature Conceptualization all artifacts that are referred during interviews are documented and at the end the user is asked to evaluate the importance of each artifact and classify the artifacts from work process' viewpoint. User can also be asked about wishes of new features and comment on features the design team has already designed. Usability Roundtables means development team's meeting to which a user has been

invited to tell about a part of his or her work and show artifacts that are related to it.

Reports of artifact analysis methods do not usually consider the characteristics of produced information. Focusing on artifacts is rationalized by arguing that artifacts make the research and results of it more concrete (e.g. Butler and Tahir, 1996; Raven and Flanders, 1996). On the other hand the biggest challenge in artifact analysis seems to be a risk of breaking away from the actual context of the users (Butler and Tahir, 1996). All artifact analysis methods either use artifacts to learn about users tasks or look at the artifacts from outsiders', i.e. product developers' and not users', perspective (competitor analysis).

Activity theory has a bit different approach towards artifacts. It sees different tools and devices as mediators of people's actions. Artifacts both enable and restrict users. Activity theory realizes that artifacts have evolved as a part of people's actions and therefore they should be handled as a part of it too. From the activity theory's perspective all research of human actions is some sort of artifact analysis, since actors (users) and objects make the actions, which on the other hand are shaped by different artifacts. (Kuutti, 1997)

## Case: knowledge support system for mobile maintenance men

This study was a part of a research project that started 2003 and ended 2007. The aim of the research project was to develop a dialogue based multimodal problem solving support system for mobile maintenance men. The developed system could be used via speech or text chat based user interface whichever was more suitable for the users' current needs and context of use. During the system development and design a group of mobile ICT maintenance men were studied with UCD's user research methods. In addition the developed system was usability tested with maintenance men.

In a first phase of the research project a user research of maintenance work was conducted. The user research utilized participatory observations and artefact interviews. Total number of 6 maintenance men was observed. The participatory observations lasted 3 to 6 hours each. After the observations a preliminary analysis of the maintenance work was conducted. The analysis was then further developed and validated with 5 artefact interviews. In each artefact interview two maintenance men and one researcher (interviewer) were present. The maintenance men were asked to bring the basic tool set they have with them during a normal workday to the interviews. Then a normal workday of maintenance men was constructed together with the maintenance men. In addition the basic toolsets were documented as suggested in artefact analysis literacy and the most important tools classified based on their purpose of use, usability and frequency of use.

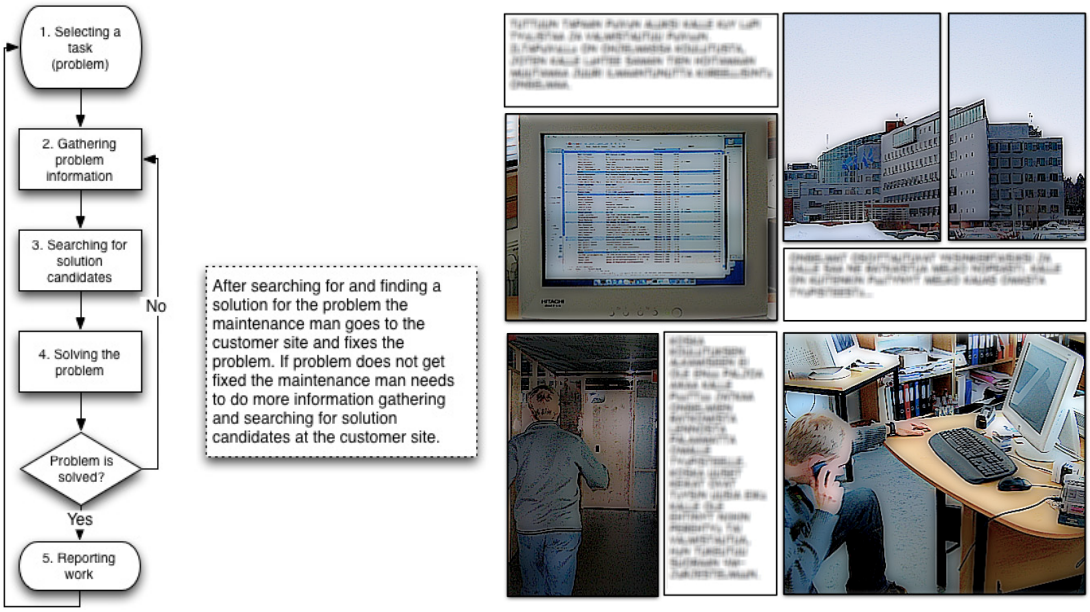


Fig 1a. Task diagram of a simple problem-solving task of ICT maintenance men

Fig 1b. Part of scenario of an ordinary workday of ICT maintenance men

Task diagrams (figure 1a) and scenarios (figure 1b) were produced to help the product developers in developing and designing the problem solving support system for maintenance men based on the findings of the user research. The research project proceeded iteratively like iterative or incremental UCD process (e.g. International Organization for Standardization, 1999). After the development phase the product/prototype was evaluated with the maintenance men and the results were used to further develop the understanding of maintenance work and design guidelines, and also as direct feedback of the design itself. During first iteration cycles the evaluation was done by showing scenarios and partial demos to maintenance men. Towards the end of the research project also usability evaluations of parts of the system were conducted. Since the project was a research project, the end result was not a finalized product but a partial prototype and thus full-scale usability evaluations or field tests could not be carried out even at the end of the project.

During the first two iteration cycles (first two years of project) an observation was made that the user research and usability evaluation methods seemed to miss some parts of the big picture. Although the participatory observations and artefact interviews had produced hints that for example the speech user interface could be problematic in many situations the maintenance men faced everyday, the evaluations did not support this finding. The maintenance men were extremely impressed even with the rough and partial prototypes of the developed system and felt positively about the speech user interface.

Since the system was only just in demo and prototype phase and could not be evaluated fully or tested in actual context of use, a decision was made to deepen the user research and focus on maintenance men's current technical tools and their user interfaces and to try to validate earlier user research findings trough them.

Contextual Inquiry (Bayer and Holzblatt, 1998) was used in follow-up user research. In addition to Contextual Inquiry interviews also the earlier artefact interview data was reanalyzed. In analysis the maintenance men's relationships with technology was the centre of attraction.

The follow-up user research revealed that in addition of different working habits and methods the maintenance men also had very different opinions and understanding of the technologies they used daily. Interestingly the maintenance men actually saw the meaning of certain IT tools and devices differently although they all seemed to use them to same tasks and almost identical ways. The maintenance men also had similar knowledge and know-how of most technologies. After all they worked as ICT maintenance men.

For example device manufacturers' web based support forums that the maintenance men used for getting information about possible solutions to occurred problems and for keeping track of current situation in the field, i.e. preparing for possible problems, were seen as a informal conversation forum and a good resource of temporary hacks by some maintenance men and as a official support channel and solution database by other maintenance men. This resulted in different kinds of tactics in using the service and especially in differences in trusting the information that derived from the service.

Most interesting findings from the research project's point of view of the follow-up user research considered natural language user interfaces, real-time context sensitive problem solving support systems, and job and task management systems.

Maintenance men were familiar with natural language user interfaces mainly trough failures. All the interviewed maintenance men had some sort of experiences with unpleasant and cumbersome natural language user interfaces relating to their work. Examples of speech and natural language user interfaces in use during the research project were:

- Hardware manufacturer's automatic call services that required the caller to spell the serial number of the broken device one number or letter at the time.
- Annoying speech output features of different PC operating systems
- Modern help systems in software that force the user to specify their problems and needs with natural language instead of allowing for example simple keyword based searches.

No current system provided as sophisticated solution as the research projects aim was and in consequence the maintenance men were so positively surprised when they saw the system that they were not capable of thinking whether the speech user interface would be useful or usable in actual work context.

Real time problem solving support systems answer to the clear need when maintenance work is considered. Naturally there have been many earlier attempts to solve same problem, but they have failed or transformed to plain knowledge databases. Even if all the technical obstacles could be overcome the corporate culture could still block the using of the system. In studied

companies maintenance department had quite hierarchical organization and bonus schemes in salary system. This can lead to fear of asking help from official parties (or from knowledge database that keeps track of its use), since maintenance men are afraid that they seem incompetent and lose their bonuses.

Job and task management are the necessary evil in case based problem-solving work such as maintenance work. Although the task of reporting one's work hours was disliked by all interviewed maintenance men, none of them could believe that any technical system could be trusted to do it automatically. It seems that the employers are afraid that the workers manage to cheat the systems and the workers are afraid that the systems cheat them.

## Analysis

User research and usability evaluations produced vast amount of interesting and useful information concerning maintenance men's tasks, working environment and needs regarding their tools. Examples of these were descriptions of normal workdays and how the work is case-based problems solving, and how the working environment can vary both between tasks and during one task.

Also information about differences between the maintenance men was found. For example some maintenance men relied on paper and pen when planning their customer visits while others used sophisticated PDA devices (figure 2). All workers had all the tools available so the selecting was based on personal preferences and not on for example company policy.

The user research provided also information about maintenance men's technical know-how and skills. However since the domain of maintenance work was ICT, all the maintenance men were experts with basic technical devices and systems such as PC's, mobile phones, computer networks etc.

All in all the information provided by user research and usability evaluations helped designers to design more usable interaction mechanics and features for the problem solving support system under development.

However, the follow-up research deepened the understanding of maintenance work substantially and even revealed important facts that the earlier user research missed completely. These phenomena, e.g. fear of using problem solving support systems and deeply rooted opinion that work reporting can not be automated, have very direct effects on the design of the system.

Figure 2. Two ways of planning and organizing customer visits. For some maintenance men the post-it note and pen provided the same functionality as a PDA would.

The problem does not seem to be that the information gathering methods of UCD or user research can not cover all the necessary aspects of users, but that the basic principle of UCD, always focusing on the actual user(s), guides designers and has guided the method developers to somehow forget the technology.

It seems that emerged user research and evaluation methods utilize many different user related things and phenomena, for example users' tools and technologies, in order to learn as much as possible about the users' needs, but while doing this can underestimate the role of the tool used in information gathering. At least in case of technology the relationship the users' have with it can be extremely important when usability and acceptability of new technical tools and devices are considered.

Also the other main viewpoint in user research and especially artefact analysis methods, i.e. competitor analysis , is problematic. It can result in situation where the users' current tools and devices are analyzed only from the product developers' viewpoint. Resulting information can be useful but the idea of user-centeredness is lost and usability of developed product becomes unpredictable.

All in all the focus on maintenance men's relationships with technology proved to be critical in the case. Many of the findings would not have come up during regular user research and usability evaluations until the product would have been almost completed and the changes needed would have been either very expensive or impossible to implement.

## Conclusions

Work has changed more and more invisible during 20th century. It is extremely difficult to know what the work actual includes based on just the title or other external identifiers (Orr, 1996). As mentioned previously, modern high-tech

devices promise to enable so many things that the actual meanings of the devices are easily lost. As a result the tools of workers will not necessary tell outsiders about their actual usage. This means that UCD designers should in addition to understanding the needs and context of use of the users, understand also the relationships the users have with different technologies. This reflects also on the user research and analysis methods. For example without the knowledge and comments of the actual users of the artefacts one cannot analyze them form their usages point of view. This is the basis of usability evaluations (Nielsen, 1993) but somehow it is not often recognized when speaking about user research or artefact analysis.

It is very easy to trip over the trick question of UCD of replacing technology with user. After all, user-centred design is a response to system centric product and technology development and tries to pull technology out of the centre of product developers' and designers' focus and push user into there. This however does not mean that one should not think about the technologies that are related to the users. No new product or technology can totally replace old ones or clear the users mind from experiences related to other products and technologies.

The reported case study shows that even seemingly homogeneous and predictable user group can have very different and surprising opinions and conceptions of their tools and technical systems in general. The opinions and conceptions are based on users knowledge and both personal and shared experiences with different technologies. Also both self-learned and outside-instructed ways of use of technologies mould our understanding and viewpoints.

This situation is near the traditional definitions of culture. Inglis (2004) condensed the manifold discussions of what culture is to: shared understanding and knowledge between groups of people. Looking at the relationships between technology and the maintenance men from Inglis's viewpoint can help on explaining the found problems in user research methods. Though the maintenance men were colleagues they also were members of other groups that use technologies. They had very little contacts with each other on their free time and had also received their training in different schools and had previously worked at different companies. Thus the maintenance men were members of different technology cultures and since they worked mainly alone the cultures had not assimilated or blended much and thus there were still big differences between maintenance men's viewpoints towards technologies.

The idea of technology culture is very different from Hofstede's (1991) classical perspective towards cultures. Technology culture is not national or regional phenomenon but at the same time more micro level and perhaps global concept. There were multiple technology cultures present in a single team of workers but the technology cultures were not probably restricted to the company. Thus there probably are members of same technology culture in different companies, perhaps even worldwide.

Concept of technology culture does not require that new research methods are included in UCD. It does however require that the frameworks that guide

UCD designers are opened up. Current approaches seem to sometimes over simplify complex issues and thus miss important aspects.

This article presents results of a single case study and thus there is a risk of over generalization. However the user-technology relationship is certainly important at least when considering new technologies. The research revealed that there seems to exist different and even surprising technology cultures among seemingly homogeneous user group but did not tell us anything about for example evolution of these cultures. Thus there is a need to study the phenomenon much further.

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