USER-CENTRED DESIGN OF MOBILE SERVICES FOR TOURISTS
A Case Study on Student Work on Mobile Design

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Abstract: In recent years, mobile technology has developed fast in Europe. We have the basic hardware but the content, in the form of services, is often missing or unattractive to the consumer. Tourism is an industry in which mobile services should be especially valuable to the user but so far few mobile applications have been successful in the market. Mobile services are said to suffer, among other things, from poor usability. The user-centred design (UCD) approach, which is widely applied in the design of mobile services and applications, is supposed to remedy this defect. We assigned 5 groups of international, advanced level Information Systems students the design of a mobile service for tourists while applying the UCD approach. We analysed and evaluated their design process as well as the prototype. Our objective is to find out how the UCD design process guided their work: What difficulties there were in the application of the UCD? Does the UCD set some undesirable constraints to design work?

Key words: mobile services; user-centred design; technology education; tourism.

1. INTRODUCTION

In the last few years, a lot of attention has been paid to the potential impact of mobile technology in all walks of life. Mobile technology brings services to people on the move where and when those services are needed. Mobile technology enhances, among other things, personalisation, the freedom of movement, localisation and collaboration. The next few years will be crucial as a major shift will take place in terms of infrastructure

(WCDMA, broadband wireless access, GPS), mobile devices (3G devices) and the features of future applications. Presently, however, most mobile applications and services are still in a tentative state.

One application area of mobile technology is tourism and related services. Because tourists are by definition on the move and usually in unfamiliar surroundings, the concept of providing personalised information and services to tourists through their personal mobile devices is appealing. The tourism industry is still looking for the killer application which will be adopted by everyone and at the same time will deliver the promises of personalisation. The problem is how to design a service for the many in a market, which has a quite segmented customer base.

In a design problem area where customer needs are likely to be fragmented, it is generally suggested that one applies a user-centred design (UCD) approach. The UCD pays special attention to user needs, incorporating them into usable designs. In 2004, it will be technically possible to develop mobile applications with an extended set of features (compared to what we are used to now): audio, video, positioning and localization features, as well as interactive features (multimodal to some extent). This extended set of features has raised the expectations of application developers, service providers, network operators and the consumers (primary users) alike.

In this paper, we discuss the applying of the UCD approach to the design of mobile services for tourists, on the basis of the course work of international advanced level students of Information Systems. We are primarily interested in finding out how the UCD design approach guides the design process and its outcome. Three issues will be addressed: 1) How well the groups applied UCD? 2) How well the usability goals were attained? 3) Are there innate constraints in the UCD that lead to an undesirable design outcome?

2. USER-CENTRED DESIGN

2.1 User-centred design

User-centred design refers to the process of designing an information system (or any other artefact) with a user-centred approach, which implies extensive and coherent user involvement in the design process jointly with the designer(s) of the system. According to Norman (1986), user-centred design aims at designing systems, whose primary purpose is to serve the user and the user's goals, not to use a specific technology, nor to be an elegant piece of programming. For some other authors, the UCD is the design of a

system based on requirements formulated by the users themselves, without any further involvement by users in the design process, except maybe at the evaluation stage where user involvement might be more frequent. There are probably as many definitions of the UCD as there are designers and researchers: the most important to remember is the emphasis on the exploitation of the user's knowledge and the involvement of the user in the design process.

One recurrent theme in the UCD is the concept of iterativeness. This is based on the insight that it is rarely the case that we capture the user requirements and provide a workable design the first time round, and that it takes several iterations to learn about the users and their requirements. Iterativeness is outlined as an important feature of the UCD processes in the ISO standard 13407. In addition to iterativeness, user focus and measurable usability are among the main driving principles of the UCD. Figure 1 illustrates the features of the UCD in a generic model.
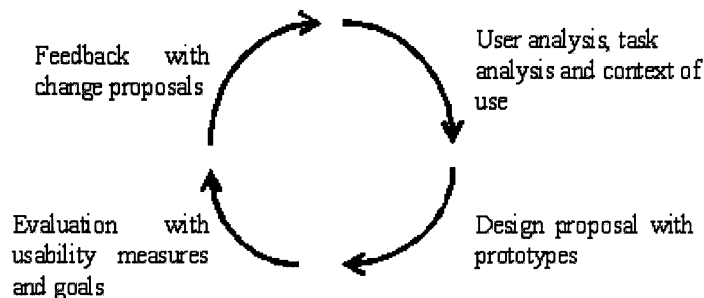

Feedback with change proposals

User analysis, task analysis and context of use

Evaluation with usability measures and goals

Design proposal with prototypes

Figure 4. A UCD generic model

Of course, the UCD is not the panacea for system development, but it is a step towards more usable systems. The UCD has lacked evidence supporting its cost-effectiveness; however, recent empirical research indicates that the UCD can be successfully integrated with other system development models, outlining best practices for achieving this (see Jokela, 2001; TRUMP project, 2001). UCD shares common traits with the newest system development models, as these have evolved from the traditional waterfall development to evolutionary system development, which promote iterativeness, incremental development, and evolutionary design. These common traits ease the integration of the UCD with these models (Gulliksen et al., 2002).

UCD models are useful for representing the activities carried out during the UCD process, and for understanding how they relate to each other. We talk about "models" because there is not only one model that will capture the

UCD process. Each IT project has its own characteristics, and it can surely be said that there are as many UCD models as there are projects.

One relevant factor that can help us make a distinction between different UCD models is the level of user involvement. There can be different degrees of user involvement depending on the project's nature. UCD models with relatively low user involvement will tend to be based on extensive theoretical knowledge about the user. UCD models with high user involvement will tend to be based on accumulation (and the learning process associated with it) of knowledge about the user "in situation" and his context. Ethnographical methods and contextual design number among the techniques used in these models. Obviously, UCD models with low user involvement will rely much on expert knowledge, whereas high user involvement will require extensive use of human resources and will be time-consuming.

Another interesting dimension that can be used to compare UCD models is how active or passive users are, in respect with what happens in the UCD process. For example, a design process might involve the observation of thousands of users: in this case user involvement might be considered to be high because of the number of users, but it will remain passive user involvement, as users are not asked to contribute to the design. On the other hand, active user involvement can take place when a dozen of users formulate themselves requirements and design proposals. Here again, it is a matter of degree: the nature of the project will determine how active or passive users will be during the design process.

2.2   UCD and mobile services

Designing for mobile services is challenging. In most cases, designers have to deal with (i) devices and technology infrastructure with a limited capacity, (ii) high user expectations and (iii) short time-to-market. Also, designers often have to design for devices which do not yet exist on the market, or which have a limited customer-user base. This leads to a situation where product concepts are launched and do not meet adequately their goals (in terms of adoption rate, reach and revenue). It is believed that the UCD could offer solutions to these design problems: by designing mobile services with the user core needs as a starting point, one can increase the odds of services success when launched.

3.   MOBILE TECHNOLOGY IN TOURISM

3.1   State of the art of mobile technology in tourism

Many scenarios have been created to illustrate the potential of mobile services for consumer market, with the tourism sector being among the most popular ones (see esp. Anckar 2002, p. 15; EC Statistics 2002). The nature of the content of tourism and cultural heritage services could open up numerous opportunities to the so-called third generation (3G) multimedia in various forms and situations. However, we must admit that the characteristics of the current technological infrastructure available for commercial use[3] cannot quite support the realization of such scenarios. Therefore mobile services and applications for consumers, including those for tourists, are still in their infancy. According to many industrial experts and consulting companies, the actual usage of 3G services is, at best, postponed until 2005.

Although the actors in a mobile commerce value chain learned from the wireless application protocol (WAP) services painful lessons about raising customer expectations they cannot fulfil, there is a necessary question to be asked again: will the services developed for the tourism sector really bring added value for the end user? More and more researchers (e.g. Groot and Welie, 2002; Carlsson and Walden, 2002) agree with the idea that the success of mobile services in general is rather a matter of creating 'killer values' than inventing 'killer applications'. It is crucial to know what things are perceived by the consumers to be valuable (Mobilocity 2001; Anckar 2002). However, due to a lack of empirical research it is not yet known what makes consumers adopt mobile services (Pedersen and Nysveen, 2003; Anckar, 2002). As the initial enthusiasm for everything mobile has by now simmered down, investors too, demand more concrete evidence than sheer technological novelty before they are willing to put their money in mobile applications or services. Presently, research on m-commerce has started to focus more on the consumers' expectations and intentions than on the theoretical or actual technological potentials. The education and training of mobile technology professionals should follow suit and pay more attention both to the creation of added value to the user and usability issues.

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[3]   With the exception of the city of London, the 3G networks in Europe are not yet available for commercial use. The Finnish operators Radiolinja and Sonera started their 3G network trials already in August 2001, but the commercial use of the 3G networks in Finland will start only when the technology needed is of the quality that customers are used to. Telia operator in Sweden will launch the 3G services commercially in March 2004.

3.2 Extant mobile tourist applications and systems

The design and usability of mobile services have been tested in a number of projects related to the development of mobile services for tourists: mobile cultural heritage, and tourism in general, has been a topic to which the community of mobile commerce professionals has paid a lot of attention. A short description of these projects is given below.

CHIMER (Children's Heritage Interactive Models for Evolving Repositories) is an EU project for studying tools and methods of mobile environment to encourage European schoolchildren's participation in building a living view of the cultural heritage of their villages, towns and regions. Models for wider applications, such as mobile cultural heritage tourism, are developed on the basis of didactic and organization expertise of teachers, museums, libraries and technical partners.

TellMaris is a project in which new technology is developed to support interaction with 3D maps to retrieve tourist information on mobile computers. Boat tourists travelling in the Baltic Sea Region are used as a case in point. TellMaris develops new means for search and retrieval of customised leisure information for the European citizen.

LoL@ (Local Location Assistant) is a demonstration of a mobile multimedia Tourist Guide. It accompanies visitors through the historical first district of Vienna, determines the user's position and provides a personal guided tour. LoL@ offers location specific content: multimedia tourist information, maps, and navigation.

CRUMPET project aims to implement, validate, and test tourism-related value-added services for nomadic users (across mobile and fixed networks). The project delivers a mobile system for tourists, which focuses on personalization and interaction facilities and uses intelligent agent technology. The system has among other things a route finder function and a geo-coding service (Schmidt-Belz *et al.* 2001).

Prototypes for mobile context-aware systems for tourists have been around for some time now. One of the first prototypes was the Cyberguide, which is intended for indoor and outdoor use and works on a variety of handhelds. The experiences from the prototype have given early insight into what services context-aware mobile technologies could offer for tourists (Abowd *et al.* 1996).

Another system with both indoor and outdoor components is the so-called REAL system developed at the University of Saarbrücken. REAL is a pedestrian navigation system which operates on different mobile devices, combining different types of location awareness technology, such as GPS and Bluetooth (Baus *et al.*, 2001).

MINERVA, tested in a Smithsonian museum in 1998, is an interactive museum tour-guide robot that guides people in the museum in an interactive manner (Thrun *et al.*, 1999).

The AudioGPS created by Holland and Morse (2001) is an audio interface coupled with the Global Positioning System (GPS). Instead of speech the system relies on non-speech sounds (i.e. spatial audio), which appear to come from the immediate surroundings through open stereo headphones. The AudioGPS is designed for sighted users but somewhat similar systems have been developed for the visually impaired.

4. EVALUATION OF STUDENT WORK ON USER-CENTRED DESIGN OF MOBILE SERVICES

4.1 Methodology

The study explores how 5 groups of international, advanced level Information Systems students applied the UCD approach to the design of mobile services for tourists. The work that the students conducted was carried out in a user-centred design course as a course project. They were given a broad description of the system that they should design (purpose, potential target user groups, technology to be used), and they were given freedom to choose any UCD methods that they thought were suitable.

This is a case study of the design work of the five above-mentioned student groups. Both the design process and the prototype are being analysed and evaluated. We present seven evaluation criteria by which we roughly sort the groups and their work. This rough analysis serves as a basis for a discussion on the benefits and shortcomings of the UCD model.

4.2 Assessment

We have outlined criteria by which we will evaluate the students' design work. The criteria derive from the UCD and IS research literature (e.g. Gulliksen *et al.*, 2002, Alter, 2002), and from our practical experience of applying the UCD to ICT design. The criteria are divided into three categories: the first category includes criteria about the involvement of users in the design process; the second category includes criteria about the business and technological knowledge that is needed to ensure the workability of the prototypes; and the third category includes criteria about the conceptualization of the prototype and its realisation from a design perspective:

- Degree of user involvement: the UCD promotes user involvement in the design activities. Involvement can vary depending on the types of projects (time and resources available): user involvement can vary between low involvement (experts or focus groups) and high involvement (large user population).
- Information sources used: how many sources have been used; what was the quality of the information sources; to which extent they have been fed into the design process.
- Business logic: to what extent the business potential has been considered.
- Technology and infrastructure: how well the existing technology (its features, constraints) has been investigated, and taken into account in the design process.
- Conceptual level: how the concept of the mobile service design problem has been defined. Do the student groups understand conceptually how the design meets user needs?
- Design level: how the design level supports the concepts defined above. Do the interaction styles chosen support effectively the service concept?
- Originality: the level of originality can vary between replication of existing designs (low originality) to innovative design proposals (high originality). An innovative design should not, however, compromise the objective of usability: "meets the user requirements in a successful way".

Having in mind a case study methodology, we used some rough statistical representations of data (low, medium, high) to depict the general results from the evaluation of prototypes.

Five groups, comprised of three students each, have carried out their project work and designed five different prototypes for mobile tourists. The UCD seems to give a great degree of freedom for subjects involved in the design process. Groups 1 and 3 followed the UCD guidelines more conscientiously, whereas groups 4 and 5 were applying the method to a lesser degree.

Table 1. Assessment of user involvement and use of information sources

	Degree of user involvement	Information sources
Group 1	Low: survey	Low: study materials
Group 2	Low: fictional user narratives	High: study materials, literature, and websites.
Group 3	High: interviews used for user profiling	High: study materials, literature, websites, methods documentation, benchmarking.
Group 4	Low: fictional user narratives	Low: study materials
Group 5	Low	Low: study materials

Group 3 has a high degree of user involvement and an extensive use of information sources; this reflects proper applying of a design process according to the UCD principles. Groups 1, 4 and 5 used sources only minimally and the degree of their user involvement, too, was low.

Table 2. Assessment of business logic and technology and infrastructure

	Business logic	Technology & infrastructure
Group 1	Considered but not integrated	Device mentioned. Infrastructure not considered
Group 2	Not considered	Device considered. Infrastructure not considered
Group 3	Not considered	Device considered. Infrastructure not considered
Group 4	Considered and integrated	Device not considered. Infrastructure not considered
Group 5	Not considered	Device not considered. Infrastructure not considered

Group 4 investigated possible business models and business knowledge, and integrated these throughout their design process. The rest of the groups paid little attention to business logic. No group did sufficiently take infrastructure aspects into consideration, nor use their knowledge about infrastructure to ensure the workability of the prototype.

Table 3. Assessment of conceptual level, design level, and originality

	Conceptual level	Design level	Originality
Group 1	Question & answer	Supports conceptual level	High
Group 2	Menu-based	Supports conceptual level	Low
Group 3	Menu-based	Supports conceptual level	Medium
Group 4	Menu-based	Supports conceptual level	Low
Group 5	Menu-based	Does not support conceptual level	Low

Conceptually, the prototypes are rather conservative (search and find); most prototypes were designed according to the prevailing interaction styles (menu-based interaction). One prototype deviated from the others by providing a concept promoting high learnability as a design objective. Most prototypes were designed consistently, providing proof that our groups had a good understanding of the basic design guidelines and their use. It was somewhat disappointing that none of the groups proposed a new concept that could be supported by future technology (this maybe reflects the fact that our groups did not investigate conscientiously enough the technology features of the devices that they were designing for).

4.3 Comparison of prototypes with state of the art mobile systems for tourists

Kray and Baus (2003) report a survey of mobile guides which have been proposed and commercialized. The mobile guides that they evaluate have been selected on the basis of the unique features that they offer or their influence in the field of mobile guides. Their evaluation is based on the following factors: the basic features offered (tourism-related services and positioning capabilities); the situational factors (context-awareness of the system); the adaptation capabilities to the physical and technical environment (for example, in case of network breakdowns, storage of information for later use, access to a scale-down version, etc.); the interface and user interaction modes (in terms of language support and multimodality); the system architecture. They claim that currently missing features of mobile guides are to be found in terms of situatedness, which is how the mobile guide adapts according to different situations such as user, context, and task status; addition of such features is believed to increase user experience and satisfaction. System adaptation is seldom implemented. According to Kray and Baus, it is also an open question whether mobile guides should adopt a client-server or multi-agent system architecture.

By comparing students' prototypes with the systems reported in Kray and Baus, we can see how the students' works position themselves in respect with existing state-of-the-art systems. Most of our students' works include basic features such as (i) information, guidance and reservation; these features are also found in the systems evaluated by Kray and Baus. On the other hand, positioning features were seldom considered. (ii) Situational factors were largely taken into account: four works included functionality to create user profiles and use the user profile information in the designed system. (iii) Adaptation capabilities were also taken into account in the prototyping of two systems: the prototypes included the possibility to store retrieved tourist information for later use, or to browse off-line tourist information content. The prototypes were (iv) not innovative at the design level: all systems allowed the use of only one language, and multimodality was not supported. In terms of (v) system architecture, there was a consensus that mobile tourist applications should use a client-server architecture, and be somewhat integrated with other services, such as reservation services.

5. DISCUSSION AND CONCLUSION

It is generally believed that the rapid development of mobile communication technology and the failure to introduce enduring mobile

solutions for tourists call for a user-centred approach to design. Five student groups to inform the design, and to obtain an understanding of the mechanisms within the mobile tourism context applied the UCD approach. The advantage of having groups of advanced level students, which share the same design assignment, is that we can compare the design processes and the prototypes. In the real world this would be difficult to arrange.

In line with the principles of the UCD approach, the design problem is not something you get ready-made but an outcome of a long and iterative research process in which the user is involved. One group did not present any preconceived ideas about the design problem but followed the UCD procedure from the very beginning and fully, which shows especially in the degree of user involvement. The UCD is easy to apply because little preparation and background research is required, but this is also its weakness. The UCD proved to give results fast, which is important as the time-to-market for mobile services is short. At the same time the UCD is highly deceptive if one skips research into technology and infrastructure; the result will be conservative, even below state-of-the-art.

The students involved the intended users in the design work for instance through interviews, and also had access to expert guidance in the form of instructor and guest lecturer support. Apart from apprenticeship, training and education cannot escape certain artificiality, that is, an element of make-believe. Moreover, design work is often even in the real world artificial in the sense that the design outcome is frequently discovered to be a flop functionally, economically or in some other sense. We ourselves feel – and the students generally agree – that the course came fairly close to real-world design work. One informant who works as an interface designer said that he especially enjoyed the theoretical framework which helped him to gather and organize his thoughts about design work. Real as they may be, bad practices are not worth imitating. Our point here is that if closeness to the real world also has something to do with a good understanding of how things work, there may – to quote an old wisdom – be nothing as practical as a good theory.

The absence of business logic is a matter of concern in our sample of UCD design work. Tourists, as one group of users, will be willing to use mobile solutions only if these add value to them, are cost-effective and reliable. Business knowledge about how to gain the critical mass is necessary to make the applications financially attractive. Market research, too, in the promising but still little known mobile tourism sector is required. Unfortunately all of the student prototypes were lacking in this respect. In a real design process, getting to know your users requires usually generic market research. Firstly, market data must be gathered about different tourist segments and various needs associated with particular groups, and, secondly,

generate ideas for future products and services that could fulfill their expectations. The user profiling is quite adequate for the design of such systems and some degree of generalisation is welcome to achieve economics of scale.

Most of the prototypes produced by the students were designed according to accepted guidelines. From a pure design perspective, the works are completed successfully; and, apart from a few minor design mistakes, an acceptable level of usability could be ensured. However, the lack of business logic consideration has compromised the expected utility of the prototypes. Utility, together with the ease of use, is an important adoption factor of new technology (Davis, 1989; Venkatesh, 2003). Often it is a matter of trade-off between utility and the ease of use. Most prototypes proposed ensured ease of use, but few actually proved to be useful in the sense of utility.

The course did not cover the whole product development cycle. It would be possible to extend the course work further to include prototype testing and a second cycle of design. However, the resulting amount of work would exceed the present limits of course work measured in study weeks.

In our case study, the UCD did not foster innovative use of technology. Innovative design can be defined as something that creates new practices that go beyond the everyday routines, rather than supports the existing practices in conventional tourism. One reason for a lack of innovativeness might be low user involvement and insufficient use of many sources of knowledge. For instance, the user involvement was usually focused on user requirements, whereas user grievances (bottlenecks in technology) did not receive enough attention. In many cases the designer was also a user in which case we can talk of participatory UCD. However, a user/designer cannot automatically be considered an expert. It is likely that a routine user of a system may become blind to some aspects of the system. Anthropologists are only too eager to confirm that an outsider often sees the routines of a culture far more sharply than the members of the culture themselves. Thus the importance of extensive user involvement and information retrieving from users as well as the use of (real) experts could be recommended.

Our case study of five groups of advanced level university students applying user-centered design indicates that the UCD is fast and easy to apply, but may tend to lead to conservative design outcomes.

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