Staffordshire University

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System Design Methodology

Assessment Project 1

"Forget the user: Do it right!
(Or: designers know best)"

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Christiane Schmidt, Florian Seidel

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1 Declaration of Academic Honesty

We hereby declare to have written the internship report on our own, using only the listed resources.

Location, Date	Christiane Schmidt
Location, Date	Florian Seidel

2 Abstract

For many decades now people have been developing computer system. And yet the process of realising, understanding, learning, and applying new knowledge to computer hardware and software development is still progressing and even speeding up.

The user-centred design (UCD) approach has been around for many years, but has been neglected, underestimated or wrongly interpreted and applied for a long time.

This paper deals with this application development paradigm and shows its impact on the success of a newly-developed system by taking a look at different case studies.

Contents

3 Introduction

For the success of system design projects it is important that the system itself will be understood, accepted and used by the potential customers.

Two important questions in a system design process are the following:
How will a system be developed? How does the system designer know that the system is really simple and secure to use? The answer is to include the potential user of the system in the system design process. The design process can make up a big part of the project time and costs. In return the success will be noticeable later-on in less training effort and higher customer and user satisfaction.

To ensure good usability the system conception should be done within the first phase of the system development project, otherwise the costs for further implementations will rise enormously. In the planning phase should be clarified which people will be using the system, which attributes characterise them, which desires do they have and which tasks will the system be used for (user analysis).

4 Theoretical Analysis

4.1 Software Ergonomics

Human computer interaction deals with the design and assessment of user interfaces. The quality of those interfaces is a critical success factor of hard- and software systems. The application should be intuitive, task-oriented and easily learnable, so that those systems can really be used. The user often measures the quality of a complete system with experiences he made with the user interface. Therefore the design of the user interface needs to be paid attention to. The users get more and more demanding and the quality requirements for interfaces are rising.

The user interface contains all parts of a software-/hardware system the users have contact with:

- the physical layer, e.g. the input devices of a system
- the layer of apperception, for example the visual design of information
- the layer of thinking (cognition), which relates to mental models (discussed in subsection 4.1.1 'Mental Models')

The area dealing with the design of user interfaces is called software ergonomics. The basics of this area are derived from apperception- and learning theory and graphical design. It is about how information could be comprehensibly visualised, how the user is supported in controlling and how the learning of the system could be eased. Computers play a big role in today's environment. Many operations are supported by information technology media and software forms more and more the human work. That's why the basics of work design have to be considered in software development. This is especially shown in the design of the user interface. Although modern development environments offer comfortable utilities to design user interfaces their development has grown as complex as the complete development itself. For that reason a methodical proceeding is essential.

4.1.1 Mental Models

Mental models have a big impact on the success of an interface. Every person develops an inner model from each system he works with. In principal this describes a cognitive representation of appearance and functionality of the system. Such mental models help the user to reach results, even though he did not use the system before or for a long time. Mental models are built via experiences and are kept in mind. When surfing in the internet experiences with the contact of websites are made in the same way. We make up a cognitive representation concerning the functioning of websites and so we do not have to pass through learning processes again and again for every site. The more a website corresponds with such a model, the easier it will be applied.

4.1.2 Quality Criteria of Software Ergonomics

A user interface should be user-friendly and has to support the tasks the user works with. These requirements are defined in the ISO-standard 9241 (part 10, 'dialogue principles'). The purpose of this standard is to present high level ergonomic principles which apply to the design of dialogues between humans and information systems. These are:

- suitability for the task
- self-descriptiveness
- controllability
- conformity with user expectations
- error tolerance

- suitability for individualisation
- suitability for learning

The criteria could be summarised as 'user orientation'.

4.2 Task Orientation

A user interface is task suitable when the system supports the task processing so that the user is not burdened with any attributes of the system itself. The user does not need extensive technical system knowledge to use the interface. The workflow corresponds with the tasks as well as the used terms correspond with the language use of the operator.

The criterion of task suitability is one of the most important ones. Software that does not fit to the tasks cannot execute the tasks correctly. To estimate this criterion the designer should have a lot of task knowledge. Only a detailed task- and process analysis and the involvement of users can provide this information.

4.3 User Centred Design

Important for the quality of human-computer interaction is the methodical proceeding of developing an interactive system. Special attention has to be paid to continuous user orientation and integration. That means that different user groups have to be analysed at the beginning of this process, to find the optimal form of co-operation. After that representatives of each group should have a major impact on the whole design process.

The design of a user interface requires specific knowledge about the future system. The first guiding principles are the requirements that should be defined in a requirement specification document. The more the project team, client and users experience about the system, the more concrete and reliable the requirements will be. Especially the design process is important for checking, testing and improving of the requirements. So could misunderstandings be discovered when the users follow the design of the user interface and see how their desires and requirements will be implemented.

4.3.1 User Analysis

The user involvement starts with the consideration of who the users of the system are. Often there is a heterogeneous group of users. They differ in some criteria, which affect on the design of the user interface. In the first step the user profiles have to be assembled. In the example of computer

systems the following points can help to identify different user groups:

- Computer literacy: Does the user already know some computer systems? Which experiences does he have?
- Which systems are actually in use and which experiences did the user make with them?
- Which functionality will the user need?
- Which requirements does the user have?
- How much does the user know about the new planned project?
- Are the users open-minded for new technologies and systems?

4.3.2 Task Analysis

The designer has to know all tasks the system should be able to execute in detail. This is only possible with the support of the current users and experts. The designer could use therefore methods of observation of the user's work as well as process analysis and interviews.

4.3.3 Prototype Design

The first prototype should be created very simple without many details and technical equipment. This prototype serves as a test how far the interface is user-oriented. There are several criteria on which a prototype can be measured:

- the learning time that is needed to solve a typical problem
- speed with which a task could be completed
- the amount of errors a user makes
- a subjective contentment

The design concept could (and also should) be created together with the user so that changes could easily be made.

The most deciding part of this process is the criticism on the draft. Users and experts have to give feedback so that the draft could be improved. There are different ways to include the user groups in that process, e.g. different types of usability testing.

5 Case Studies

5.1 Drowsy-Driver Detection and Warning System

The aforementioned theses can be proved on the following case study:
A User-Centred Drowsy-Driver Detection and Warning System (July 2001 - September 2002)
The case study of the National Highway Traffic and Safety Administration is about the development of an effective, validated drowsy-driver detection and warning system that should be implemented in commercial motor vehicles. The study is based on a 'previous work resulted in an independently validated measure of drowsiness that was then incorporated into a drowsy-driver prototype monitor.'[1]

The goal of the project was that 'this effort and subsequent field trials will result in a reliable, smart system that convinces drivers that they are driving in an unsafe condition and to make a wise choice, stop and rest.'[1]
For the design process the developer team included design experts and commercial motor vehicle drivers.

Like described in the first section, an involvement of users is necessary, especially in a project like that. Through the selection of different user groups the designers had the possibility to get a variety of different user opinions and could develop the system really user-oriented. With the different user groups it was better to 'identify and understand the users' goals and tasks, the strategies they use to perform the tasks, the tools they currently use, any problems they experience, and the changes they would like to see in their tasks and tools' [2].
The user involvement is shown in 'studies of overnight commercial trucking operations'[1] that have been made with some volunteers. Hence a prototype of an infrared camera system could be developed.

The task analysis of the system was really intensively done. To make the designer understand the problem space the team 'included literature reviews, brainstorming sessions, field visits, and thematic explorations that culminated in an expert/advisor focus group and a user focus group'[1]. The designers got an insight in the driving process, desires and requirements of the drivers and acceptability issues by sitting together with a driver focus group.

However, a conflict arose between the user and designer groups. It was about the user acceptance of the system. The conflict solution was done in the final design where both views were incorporated. At the end of the project stood a complete prototype of a user-centred drowsy-driver

detection warning system that should further be piloted with several drivers and send to an over-the-road-test.

As a conclusion the project was really successful. The interaction of designers and user was very intensive in this project and, of course, necessary. The project could not be imagined without user integration, because the user is not only indirectly but directly in the centre of the system.

5.2 User-Centred Iterative Design for Digital Libraries

User-Centred Iterative Design for Digital Libraries

(University of California, Berkeley Digital Libraries project, 1996)

This case study shows a general approach of user centred iterative design and illustrates the development of a user system with the assessment of user needs.

The system that should be designed, called Cypress, 'is an image retrieval system that is linked to the larger UC Berkeley Digital Library'[3]. It is an online-database that is under continual development and stores about 13,000 colour images and metadata from a Film Library. The digital library offers the possibility to search on textual and image attributes, which results in a very powerful search. The digital library is used by a high number of people every day.
In every design process the analysis of user groups is the first action taken. In this project there were different groups of users identified: The film library staff, publications staff, information officers, engineers and lawyers. Because the digital library is a very complex system and the searching process a really different and complex one, the designers have to analyse first the information needs and purposes for the digital library. That means in principle understanding what the users are doing with the system and how they are going to do this - the analysis of special user tasks.

Like mentioned in section 4.3 user centred design requires the willingness of users to engage in the design process. In this special case the 'film library staff and management were eager to work with'[3] the team, which pushes the project to success.

In analysing the case study we want to emphasise on the detailed user task analysis that has been done. The user requirements present at the end the functionality of the system itself. The different aforementioned user groups were analysed separately due to their work within the digital library. The designer team spent nearly half a year to interview the groups. They used another effective method to find out more about the user requirements: observation of the users about their regular work. Those observations will detail often more information about functional requirements of a system than simply interviewing the users.

Additionally to the different user groups the designers split them into "insiders" - those staff with more knowledge about the system - and "outsiders", users with less knowledge. The differentiation led to a user-centred development of two different query forms, so that outsiders would not be confused of too many details and insiders could do an advanced search.
The system was prototyped with regard to all problems that users had before and all requirements they have had. The designers had to know 'who the users are, how they do their work, the

purpose for which they will use the library, their needs and prior knowledge, and their response to the prototype: in other words, user-based, iterative design'[3].

Some open questions that occurred while analysing the case study, were in how fare the designers should adapt the system to the user requirements. It would not be reasonable to design an interface for every kind of user, every type of knowledge or every user group. Finally the designers should decide together with the users how many different system adaptations are possible. In this study more than two different interfaces were not acceptable.

5.3 Interactive Television Application

The following case study shows another *'successful adoption of a user-centred design approach during the development of an interactive television application'*.

This case study discusses how a user-centred design approach was successfully adopted during the creation of an interactive program guide (IPG) by Microsoft Television. The IPG allows users to scan television shows listed in a grid format, search for television programs by categories or keyword, set TV reminders so they are informed when their favourite television program is on, and set parental controls for rated content.

The major focus of the development team was on the application's usability and simplicity. In order for the successful integration of the usability issues into the development process, the entire team should be convinced of the need for a user-centred approach.
In this case, the product team was not aware of how effective the support of the usability team really was. On the other side usability was not aware of how the project's milestones were defined and at what milestone the team was currently at. To bring the two teams together, usability showed what a great impact usability had on former projects.

When started usability set up the benchmarking lab studies and identified a set 13 core tasks most users supposedly would like to complete, e.g. finding out the name of the TV show currently on, searching for a TV program, setting a list of favourite channels, or setting parental controls. These tasks were then given to test users, who were observed on how quickly and successfully they performed those tasks. This benchmarking approach showed the degree of improvement to the team during each stage of the development process.

A special report format was designed to track the user experience and the progress of the project. Almost as important as the reported results itself is that they are delivered to the product team on time and in a reasonable amount of time. The after the study sessions finished the report was available to the product team. This kept development's trust in the common business goal.
Every time a design recommendation was formulated usability had to file this as a UI bug, so the responsible person for this section of the application had to perform the changes and adjustments.

Close to the end of the design process competitive evaluations were conducted. For that 10 new test users were faced with nearly the same tasks as the test users before, only that the tasks had to be accomplished with the IPG as well as with product developed by the competition. The results proofed that the UCD approach was successful as the IPG received much better feedback from the testers as the other product.

To sum up, via the UCD approach usability achieved that 90% of the users who evaluated IPG found the easier to use, required fewer steps to complete tasks, completed tasks more easily, and found the user experience more visually pleasing than the competitive product.
Usability found though that running the competitive studies earlier in the design process could save a lot of time on development as the same mistakes that the competition had done, don't have to be done again by their own product team.

In addition, usability emphasised that thorough field and market research should be performed in advance of the actual design phase as time is short during development.
Now comparing this with the theoretical part mentioned above the following can be seen:

- Software ergonomics is applied by usability. They define tasks that users supposedly would like to complete, which shows the task orientation. One major issue that the whole project team always keeps in mind is the application's simplicity so that it is easily learnable and therefore fulfils another software ergonomics criterion.
- The ISO quality criteria also reflects in this case study as self-descriptiveness and the conformity with user's expectations are always kept in focus.
- It is also identifiable that this application development approach is user-oriented as thorough user analysis, task analysis, and prototyping and benchmarking techniques were involved.

Thus it is safe to say that the UCD approach not only contributed to but was mainly responsible for the success of the Microsoft Television IPG 1.0.

6 Conclusion

To build an ergonomic system not only user friendliness but also task orientation should be covered. A user-friendly system is not efficient when tasks can not be executed. Just as little useful is an efficient system that nobody can use.

The user or at least the usability department in a software developing company is a very important part and should be introduced to the project in the early design phase.

Official standards have been developed including issues as suitability for the task and self-descriptiveness, which emphasises the importance of the user-orientation within hardware and software development projects.

7 Appendix

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