IMPORTANT DESIGN PRINCIPLES FOR THE CREATION OF USER INTERFACES

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Abstract

This research focuses on important aspects for the theoretical design of a user interface. Meeting the needs of the user is often a challenge for the developer since it is necessary to get a point of view from the user. Besides the technological development process it is important to create a user interface in theory to avoid spending time and costs for improvements and further development after the release of the software or the device. The purpose of the study is to create an understanding for important criteria for designing a user interface. These criteria are required to meet the needs of an effective human-machine communication. This study is performed with the help of a qualitative approach. The collected information in the theoretical part will be supported from the data of the empirical part. This research wants to present an investigation about attitudes which are important for the user of a user interface. The study will point out important aspects from the field of Human-Computer Interaction. Human-Computer interaction can be seen as a part of informatics and mainly treats issues regarding to the communication between humans and the computer. Furthermore, Usability Engineering is a part of this study. Within this field, points of how to ensure the usability of software or a device are mentioned. As last area, Graphic Interface Design is in focus. Graphic Interface Design affects the creation of a user interface as well as the consideration of already given theories about Human-Computer Interaction. Within this area, aspects for the design of a user interface and their attitudes are discussed. The result of this research will be presented in text form by answering the research question ‘What design principles are important to use when designing a good user interface’. Within the study it will be shown that the user itself is one of the most important factors when designing a user interface. Given standards and theories allow getting a perspective from the user. But also hardware aspects must be considered when designing a user interface for a specific device. It also will be shown that nevertheless the technological development processes within the information technology, fundamental design principles of Human-Computer interaction are still important.

Keywords: Efficiency, Usability, Design, Development process, Information technology.
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1 Introduction

1.1 Background

The first computer, which were able to calculate and which needed a special power supply for doing their exercises, were invented between the years 1930 and 1945. One of the responsible persons was Konrad Zuse. He created the proper first computer called Z3 (Weiss, 1996). This machine was the first machine, which was able to calculate with floating point numbers. It was only usable by scientific personal. When the first computer was invented in the year 1941, the impact of this technology was not predictable. From the point of view of the size, this system needed nearly a whole house and thus of course it was not possible to take it away like we do it today with our mobile communication devices. But a time travel from the invention of the first computer, 1941, to the successful launches of the Apple and IBM-computers changes this picture. In the year 1981, the IBM-computer was introduced (Goth, 2011). The advantage of this machine was the possibility to copy it and thus a lot of manufacturers sold IBM-compatible machines for a cheaper price. In the same year, Microsoft introduced the operating system called MS-DOS. Computers were now available for nearly everyone and the aspects of usability became more important. Here the question appears: What do we understand by the term usability? We can divide this term into two words: Usage and Ability. The problem a designer was faced at this time was to create a user interface, which was also usable for end-users and where no study or a scientific degree is needed before the usage.

Today, we are faced with user interfaces on nearly every electrical device, such as mobile phones, laptops, smartphones and desktop computers. But also washing machines and microwaves use a kind of user interface to receive the input from the user. Also in our car we are faced with a user interface, for example by using our navigation system or even during the usage of our radio. Designing an effective user interface is also important regarding to security issues. Modern aircrafts, like the new introduced Airbus A380 for example, have complex technical equipment, which need the full attention of the pilot (Anon., 2006). Here, a wrong design can not only lead to frustration, it can lead to accidents and even to death. The rise of the computer has not stopped yet and it seems to be a normal part of our life, especially within the area of the mobile communication and within the field of mobile Internet usage (Hanson, 2011). Also with the so-called social networking platforms, the Internet becomes more and more important for more groups of people. Within this development process, also people must be considered who had less contact in their past with the information technology. Shneiderman and Plaisant (2008), point out the importance of new technologies and possibilities within the information technology in their preface for the book Designing the User Interface. However, Shneiderman and Plaisant (2008, p.vii) describe that “much work remains to improve the experiences of novice and expert users who still struggle with too many frustrations”. The mission here is to find an interface for the new technology and the user, so that the technology is usable. This affects especially older generations who have not grown up with the information technology. Here, the challenge of the designers lies in the simple design of a user interface which is easy to understand and easy to learn. Also economic aspects play an important role. The challenges for a creator of a user interface start at the beginning of the theoretical phase. Here, the needs of the user must be determined. It is also important to adapt a user interface to an existing hardware device and its properties. For a theoretical development of user interfaces, different approaches are available. Also standards in terms of usability are already established; however they have to be interpreted by the designer.
1.2 Statement of problem

In modern life we are surrounded by technical equipment. Also a life without computers would be no longer possible for some people. Likewise, the use of new information technology also plays a major role in the business sector. In this respect it is important to develop these kinds of devices for users who have less technical knowledge. A device must also be useful for a user without the requirement for a long training period before the usage of the device. In the economic sector the efficiency of a device from the category of information technology plays an important role. The efficiency of a device depends also on how much effort is needed to use device. This point also includes the learning time which is needed to learn how to use the device, but also the usability during active operation (Anon., 2011).

The challenge for a designer of a user interface is to create an interface between the device and the user. In the ideal case, this interface should be easy to learn for a user. Also part of this challenge is to avoid frustration of the user during the usage. Frustration can lead to less efficiency during the active operation, seen from an economic point of view. Another responsibility of the user interface designer is to bring the new technology to inexperienced users. With the help of a suitable user interface, the first hurdle can be taken since the user uses the user interface to control the device. Due to the different challenges and requirements for a user interface designer, this study shall point out important aspects and methods regarding to the process of user interface designing.

Since the technological development still goes on, new features will be available over the time, old features become useless. In order to make those new features usable for many users and many generations, further research is required to point out important aspects regarding to the design of a suitable user interface. However, it is not only the technology, which changes over the time. It is also the user itself and the behavior of the user, which keeps not always constant. Thus, further research is needed within this field.

Seen from my own perspective, within a good user interface the user should be able to accomplish a task without spending too much time for the user interface itself alternatively the user interface should be invisible in a way for the user. The user interface should serve as a tool for the user and not as an extra challenge. The tool should be easy to use so that it provides an easy usage of the software or the device. A user interface should also help generations, which have not grown up with the information technology. Thus, these generations will also be able to use the new technology. These goals can be reached by the designer by considering important aspects and design principles, regarding to the user interface design. Those principles shall be derived within this research.

1.3 Purpose of the study

The challenge within the design process of a user interface is to meet the needs of the user. It is important to find the right approach to develop the user interface for its right purpose. The user interface is designed for the usage of a device and thus it must be developed primary for the human actor. It is often not easy for the developer to see the situation from the position of an inexperienced user. In the normal case, the developer is familiar with the own created software. This study shall help a developer to get a feeling for the needs of an inexperienced user. The purpose of this study is to create an understanding for important criteria in relation to the design process of a user interface, which are required to meet the needs of an effective human-machine communication.
1.4 Research questions

Within this study, I want to try to give answers to the following question:

• What design principles are important to use when designing a good user interface?

1.4.1 Sub questions

The main research question includes the following sub-questions:

1. Which options are available to help leading users through a system?
2. What are important design principles for increasing the usability of a user interface?
3. Which aspects are important when designing a user interface for a specific device?
4. How is it possible to avoid creating barriers for the user while designing a user interface?
5. How is it possible to avoid an information overflow and thus confusion for the user?

1.5 Target group

Especially the designers of user interfaces are the target group of this thesis. The thesis is mainly focused on theoretical aspects which are important for the creation of a user interface. It shall provide important points for the designer and provide a guideline while designing a user interface. The content of this document shall provide information for the designing process for personal computers and mobile communication devices. It may also provide useful information for web designers, since this area of the information technology is also part of the creation of a user interface.

1.6 Delimitations

This study focuses only on theoretical aspects. This means, that technical issues are not part of this thesis. Technical implementation and development software will not be discussed in detail within this thesis.

This thesis will also focus mainly on desktop computers, laptops and mobile devices. The design of user interfaces for other devices, for example medical or specific car devices, will not be discussed in detail within this thesis. However, it should be possible to pick out useful information for the design of user interfaces for other devices since some aspects can be treated as common aspects.

1.7 Expected outcome

Information technology is used in more and more areas of our lives. It is therefore important to develop equipment and technologies which are easy to use for everyone. This investigation shall highlight important issues which can appear during the theoretical development process of a user interface and provide possible solutions for those problems. By the help of this research, also possibilities for increasing the motivation for a user regarding to the usage of software or a device shall be shown. Thus, these opportunities for increasing the motivation level of a user can be considered during the design process of a user interface. Another expected outcome of this research is the possibility to use this study as a guideline for the whole theoretical development process of a user interface.
1.8 The authors’ own experience and background

As a former worker in the IT department of the Ulrich Alber GmbH, Germany, I was faced with several problems which affect users directly. A big part of these problems had their roots at the user interface itself. Thus, it was hard for the user to make the right steps to perform a task with the help of the software. Especially ERP-software, which contains many options and hence is complex software, was affected. Due to my apprenticeship at the same company before the work as a first level supporter, I am also able to provide a point of view from the user perspective, since the apprenticeship included working in many of the companies departments. Due to my studies after my employment I gained more technical details about user interfaces and the behavior of users itself. My study contained also theoretical aspects about the creation of a user interface. As a student in the field of information technology I am able to provide knowledge in the field of information technology. This will help to find the first steps for my research and to focus on the most important part while designing a user interface: The user interface is for the user, not for the programmer.

1.9 Structure of the thesis

Chapter 1 - Introduction
Within this chapter, a background for the thesis is presented. The purpose of the background is to lead into the topic itself and provide some basic information on why this research is done. Also the own experience of the author as well as the main purpose of this research are explained here.

Chapter 2 - Research Design
Within this chapter, the strategies and methodologies which are used for this thesis are explained. Also the explanation of the ways how the data were collected and analyzed is a part of this chapter.

Chapter 3 - Theoretical Study
This chapter includes the theoretical part of this research. Within this chapter, given standards in relation to the theoretical design process for user interfaces are presented. Also important aspects from relevant literature and important research areas will be mentioned and discussed here.

Chapter 4 – Empirical Study
The empirical study includes the interview with an experienced designer for user interfaces. Within this chapter, the point of view from an experienced developer will be presented.

Chapter 5 – Analysis and Result
The collected data from chapter 4 and chapter 5 will be analyzed here. Both chapters will be compared in relation to practical application and confirmation of the theoretical data.

Chapter 6 – Conclusion
A final statement will be given within this chapter. Also a conclusion will be presented and discussed. Furthermore, the implication of this research for informatics and a possible generalization will be mentioned. Finally, ideas for a continued research and assumptions for the future can be found here.
2 Research Design

Within this chapter, the methodology which is used for this research will be explained. It will also be explained why specific methodologies are used for this research. This part will also describe how the data will be collected and processed.

2.1 Research perspective

Before the start of a study, it should be clear which research approach will be chosen for the research project. For the investigation within this study, two approaches are in focus: Hermeneutics and Positivism.

The approach with the usage of hermeneutics helps especially in the field of social research. With the method of hermeneutics the behavior of human being and human actions can be studied by the help of subjective approaches in relation to the research project. This means, the results have to be interpreted by the researcher. The research approach by the help of positivism focuses more on objective approaches. This includes for example natural and mathematical sciences (Bryman, 2008).

For an approach by the help of hermeneutics, this means a start of the research from how the researcher understands the given problematic. One of the reasons why an approach with hermeneutics was chosen is the goal of this research. This thesis has the purpose to create an understanding for important criteria for the design of a user interface. As mentioned above, hermeneutics is used as an approach within the field of social research. Hermeneutics is an approach to interpret social behavior and human interaction. Especially for the interview, the received information has to be interpreted. But also the data which will be collected for the whole study can be seen more as possibilities, not as fixed facts. The main data for this study is mainly collected from academic books and scientific articles as well as from an interview. For this reason, a qualitative study is performed, since the goal of this approach is to interpret the collected data. Gubrium and Holstein (1997), who are mentioned by Bryman (2008) suggests ways for performing a qualitative study:

- Naturalism: Tries to understand the reality.
- Ethnomethodology: Tries to understand how social behavior and order is formed by conversations and human behavior.
- Emotionalism: Tries to understand inner attitudes of humans and human behavior.

The points mentioned above contain the approach to understanding a specific research area. The main difference between the qualitative and quantitative method is the way in which the data will be collected which is needed for the research. The result of quantitative research is easier to present, since the collected data can be presented in diagrams and numbers. This method is also used for statistical issues, since the way of collecting the data makes it possible to create a specific statistic. Wherefore quantitative data focuses more on the collection of fixed data, the qualitative approach focuses more on the behavior of humans in depth. This kind of research perspective is often used in social sciences (Bryman, 2008). Within this research, the main line will be set to the qualitative approach. Since I am doing an internship at Opera Software ASA, this gives a good opportunity to find out more information about
important points regarding to the research questions from the point of view of an experienced designer, responsible for user interfaces.

2.2 Research strategy

The definition of the term *Research Strategy* can be summarized as the following: A research strategy is the course of action which is taken to collect relevant information for the research. Depending on the research questions, this includes the plan how the researcher can get information regarding to the topic in an efficient way and in a defined time range. This strategy contents also the time and financial funds available for the researcher. If a study is performed, it is recommended to know the research strategy which is used for the study. Following Bryman (2008), one of the strategies for gathering the information is the *deduction*. Additionally, *induction* and a combination of both would be available within this context. If a study is performed in the inductive way, it means that the researcher starts directly with the empirical study without based theory. Outgoing from the results, reached by the help of the empirical study, the researcher then forms a theory. The deductive research strategy means to start work with existing theories (Bryman, 2008).

This research will work in the deductive way. The reason for this way is the already given research in this field. Thus, there are already many existing theories. However, as mentioned in the introduction, this area is in movement and still provides possibilities for further investigation. The research starts with theoretical parts; therefore, the research has theory as its foundation. For finding out if the theory matches with the reality, the empirical study which includes an interview with an experienced user interface designer, will be used to try to confirm the theoretical findings. However, if there are differences between theory and reality, those points will be highlighted. Also additional information, gathered from the interview, will be mentioned. Thus, the interview offers a view from the reality.

2.3 Data collection procedures

Under this topic, we understand the way how the data which is needed for the process of this study is collected. There are different approaches how to collect useful and necessary data for a specific topic. For this thesis, the primary as well as the secondary data is in focus. The primary data is collected by the researcher for example with the help of interviews or questionnaires. Also the observation is a method for collecting primary data. Within the collection process of primary data, the researcher has also more possibilities to choose in which way this data will be collected. Thus, the researcher is able to collect data in the way which provide the most information required for the research topic. As a disadvantage of primary data the effort for this way of research should be mentioned. The steps for preparing an interview for example, need more time, also the analysis of the results. Another disadvantage can be the financial efforts which are required in relation to the collection of primary data. These financial efforts can include the travel costs for the interview or the costs and the time for getting data from a questionnaire. Secondary data consists of information which is gathered by other persons. This collected data could have been gathered for other reasons as the topic the researcher is doing a research for. But it could provide useful information which is important for the researcher. By the help of secondary data, it is possible to create a foundation for the research. It can also help to reduce the financial expenses regarding to the research itself. Another advantage of secondary data is the possibility to get a look at research which was done for a longer period. For example the look at the figures of a company can provide information about the past success of the company. This information
can be gathered in a very short time. A disadvantage of secondary data is at one point that it is maybe required to sort out the information needed for the own research topic since this data could have been collected for another issue (Bryman, 2008).

Within this thesis, a combination of both methods is used. Since there are many researches available, which provide information in relation to this topic, this secondary data will be used for getting relevant information for this research. Primary data will be used to focus more on specific issues and get a point of view from a developer of a user interface. The primary data shall also be used to confirm findings from the secondary data. In the following, the used sampling methods for the theoretical and empirical part of this study will be discussed.

2.3.1 Theoretical part

For the theoretical part, secondary data will be used. The data will be chosen from scientific articles, which contain relevant information for this research. Also scientific books are in focus for this study. Within this part, the approach is to find out which data has been collected yet and which questions are not answered yet. Following Bryman (2008), the Narrative Review is an approach which meets the needs of a study, performed in an interpretative way since this approach is less fixed and thus provide a bigger perspective.

2.3.2 Empirical part

For the empirical part, the interview has been chosen to get more information for answering the research questions and to acknowledge theoretical findings or to point out differences. Due to my internship at Opera Software ASA, I have the chance to get direct information from a developer’s point of view, since this company is involved with the creation of user interfaces. Therefore user interface designer are working at this software company and it will be tried to establish a direct contact to a user interface designer with the goal to get first-hand information. Following Shneiderman and Plaisant (2004, p.4):

“Human performance and user experience with computer and information systems will remain a rapidly expanding research and development topic in the coming decades.”

Thus, it is important to get an actual point of view from an experienced user interface designer. Since the company is also affected by the changes within the information technology, adaption is necessary for the company. The interview shall provide a current point of view.

2.4 Data analysis procedures

After the collection of primary and secondary data, an analysis of this data is required. This means to point out important information in relation to the research questions and the research topic. Also the quality of the data needs to be proved. Especially for secondary data, this is an important point which has to be considered. The conclusion of the empirical study is written down in text format and it will be compared with the data collected for the theoretical study. Within this thesis, this will be done by the help of a qualitative approach which means that the collected data will be filtered for relevant information regarding to the topic. The last step shall help to categorize the data in a way which makes it easier in the next stop to prove the theoretical part within reality by the help of the empirical part.
2.5 Strategy for validating findings

Within this research, triangulation methods are used to verify found research data. Bryman (2008, p. 700) describes Triangulation as the following:

“The use of more than one method or source of data in the study of a social phenomenon so that findings may be cross-checked“

Thus, triangulation provides help validating findings by performing cross-method research or by the usage of multiple data sources. Triangulation is used mainly for quantitative research approaches, but can be also used within qualitative studies. Within this study, method triangulation will be used by comparing the theoretical findings with the empirical results. Also data triangulation will be used for validating the findings, since the data for the theoretical part will be collected from different sources. One kind of sources here are scientific articles, which can provide important key information regarding to this research topic. Other sources are academic books, which serve founded information in a larger amount in relation to the research topic (Bryman, 2008; Denzin, 1998; Syahrina, 2011).

2.6 Result presentation method

The main presentation form within this thesis is written text. The text is divided into three parts. Pictures are used to serve a better idea of given concepts. For comparison between specific data, tables are used to highlight the differences.
3 Theoretical Studies

3.1 Key concepts

User: The Person, who uses a specific technical device or specific software. This can be the case within the private environment as well as in the business environment (Smith, 1997).

User Interface: The interface between the human user and the technical device. By the help of this interface the user is able to send inputs to the device to be able to use the device.

User acceptability: The user acceptability stands for the acceptability and the inner attitude of the user regarding given software or a given device. Reaching high user acceptability is a part of the work of a user interface designer (Ferre, Juristo, Windl and Constantine, 2001).

User Interface designer: The person who is responsible for the design of the user interface. This can be seen from the technical point of view as well as from theoretical perspective of a developer.

ISO-Standard: ISO is the short term for International Organization for Standardization. An ISO-Standard defines criteria which describe the usability of products from different manufacturers among each other.

Software Usability: This term stands for the operability of given software. The better the usability is considered during the process of the software development, the higher is the acceptability of the user regarding to the software. By the help of this term the explanation for the following word can be derived (Ferre, Juristo, Windl and Constantine, 2001).

Software Quality: For this term, the ISO/IEC 9126 plays a major role. Within this standard, key concepts for quality of software are defined. Factors regarding quality are among others functionality, reliability and usability. Within the design process of a user interface, this point is very important (Ho-Won, Seung-Gweon and Chang-Shin, 2004).

Software Efficiency: This term is also findable within the ISO/IEC 9126 standard. One aspect, which is described by this term, is the performance level of software in relation to (financial) resources used for a specific purpose (Ho-Won, Seung-Gweon and Chang-Shin, 2004 and Anon., 2011).

Input Method: Describes how the user is able to send an input to a device alternatively the user uses the device.
3.2 Subject areas relevant for the research

Within this study, the approach answering the main research question by the help of answering the sub questions will be used. The main research question is answered mainly by the theoretical study. The empirical study shall help to support the knowledge from the theoretical study. This study affects three main research areas, which will be described in the following.

As a first point, Human-Computer Interaction is in the focus. Here, the behavior of the user and user characteristic are an important research area for this study. For the designer, it is important to know the user and the way how the user interacts with a device. It is also important how the user reacts to different signals, given by the user interface. This chapter mainly affects the sub questions 1 and 4.

As a second category, Usability Engineering will be examined. Usability is part of this study since an important point for the creation of a user interface is the usability. To reach an appropriate usability for a product or in this case a user interface, important aspects must be considered to reach this goal. This chapter affects the sub questions 1, 2, 4 and 5.

A third area, which is important for this topic is Graphic Interface design. Design aspects are very important for the whole process of the creation of a user interface. Here, theoretical aspects from the above mentioned fields are considered, when implementing elements with specific techniques into the user interface. But also design issues are part of this section. This chapter shall provide answers to the research questions 3 and 4.

Figure 1: Subject areas relevant for the research
3.3 Previous research

There are different researches available in relation to user interface design. Young (2010) focuses in his research on cognitive user interfaces. He points out that cognitive user interfaces are very important for computer systems in the future. He describes furthermore the rise of touch screens with the combination of gestures and voice input. Another point which is mentioned in his research is the behavior of a user interface in a natural way. A user interface of the future should be able to react on facial expressions and voice input from the user. Also a user interface of the future should adapt itself on a given situation.

Provenza and Piccinno (2010) describe an approach for a flexible user interface. They describe the importance to design a user interface not only for one specific group of persons. They point out that is should be possible to customize a user interface for the own needs. It should be possible to add new functions and possibilities without any programming knowledge. Anyway, the user interface should be still easy so use. Thus, it should be possible that the user interface is adaptable by the user to a certain situation.

Another study, made by Chou and Hsiao (2006), describes the usability on human–computer interfaces for middle-aged learners. They point out, that older generations have different requirements regarding to a user interface then younger generations. Younger generations had a better opportunity to learn specific human-computer interactions since they have grown up with computers and had better opportunities to learn the usage of computers during their time in school.

3.4 Relevant literature sources

The name of a known author in relation to research in the area of user interfaces is Ben Shneiderman. As an author of books in context with user interfaces he has set quasi-standards and is seen as essential in this relation. Ben Shneiderman was in involved in the development process of the so called Nassi-Shneiderman-Diagram which is used for describing a program flow in a graphical way. Shneiderman is working in the Department of Computer Science as a professor. From 1983 until 2000, he was working for the Human-Computer Interaction Laboratory. Currently, he is also working at the University of Maryland (Shneiderman and Plaisant, 2004).

Another important name in the area of interface design is Jakob Nielsen. In his book, which was written and published in 1989, he focuses on consistency. The book was reprinted in 2002, since following the author most principles of usability did not change over the time. He points out that consistency within a software project is not only an advantage for the user; it can also be an advantage for the company within the development process. In his book, several concepts of keeping a consistency and where to keep consistency are described (Nielson, 2002).
3.5 Human-Computer Interaction

3.5.1 Important aspects for Human-Computer Interaction

When a human interacts with a computer, some similarities with interacting with other things in the world can be found. A human remembers things and ways to reach a goal and thus, the human adapts to it. People develop a specific feeling for the behavior of computer systems and expect the same behavior in the future. But the human is also a creature of habit. It is sometimes hard to adapt to new things and situations, also in the field of information technology. Especially, if the old software or the old device still do their job. Thus, also no change in the current behavior of a user is necessary – seen from the user perspective. But seen in common, the human behavior is changing over the time. This means also a change in how we use devices from the field of information technology. It should be clear that the way how the human behavior changes also affects the design of user interfaces. Compared over the time, mobility aspects become an important factor regarding to this. Devices are getting smaller and the need to access the internet during being on the way rises. Also the way of our social behavior has changed. We prefer now to communicate via social networks since we are able to influence this way of communication with pictures and special applications. But not all generations are affected by this. It often depends on the social and economic development status of a country. Also the education level plays an important role regarding to the usage of information technologies and the new ways of communication. Countries, which provide a good communication infrastructure which includes amongst others broadband internet and a high technological level, have therefore a higher education regarding new information technologies. This starts even within the childhood. Children, grown up with the information technology have a different behavior when interacting with devices compared with generations who are not grown up with the new technologies. The behavior of a human regarding new technology is also a question in which relation the human stands to this kind of technology. It is also important to understand the motivation aspects: Is it necessary to understand the new technology or do I want to understand the new technology. Especially for older generations, this question can be essential from the psychological point of view. If it is necessary to understand a complex computer system, the motivation can be lower if there is a constraint to understand the new technology. Thus, it is a challenge for the designer of a device, especially for the user interface designer, to raise the motivation level of this kind of user. A different point of view provides the look at younger generations, which are grown up with the new technology. These kinds of users see this technology as a normal utility for their live. Thus, the motivation level to understand a new device or new software can be higher. For younger generations, new technologies are also seen often as a toy. Of course, the video entertainment industry provides products especially for this purpose. But also new social platforms are not only seen as a way for communication and interaction with other members. Also mobile devices can be seen as a toy from the point of view of a younger human. Seen from a child perspective, a toy should be discovered for its attitudes and features. For the designer, this aspect can also be important criteria for the design process of a specific target group (Markopoulos, Read, Hoysniemi and Macfarlane, 2008; Thioune, 2003).
3.5.2 Defining the user

In every field which is available within the information technology, users can be categorized in different ways. We have to separate users from the professional field within business and end users, which use the system for private issues. In both categories, the user wants to reach a goal while handling with a device or software. On the one hand, this can be completing a task in relation to work the user is confronted with. On the other hand, also completing a task in the private area of the user can be one of the goals. The user is the person who acts directly with a system from the information technology. Thus, the user is also responsible for handling with the device. Also, the user is responsible for a possible success of a device or of specific software. The user interface is designed for the user and thus it has to be optimized for the user. (Smith, 1997)

3.5.3 Understanding the behavior of a user

Before the start of the design process for creating a user interface, the user itself needs to be investigated. The user interface must serve the user, thus more accurate knowledge of the user is necessary. At first, the field of activity of the user needs to be investigated. The designer must get a point of view of the user to understand what should be achieved with the user interface. Depending on the working environment of the user, the interface design must be adapted. A user interface of a program for the area of word processing, for example, cannot serve the purpose of surfing the Internet. When designing a user interface, it is important to put the focus only on elements which are really needed. Otherwise, this can lead to confusion, especially among novice users (Shneiderman and Plaisant, 2004). Another important part to consider is the difference between a human and a computer system. This might sound simple; however it is important to find a way to optimize the communication between each other. Singleton (1971) developed a relation between humans and computers and thus created a direct comparison:

<table>
<thead>
<tr>
<th>Property</th>
<th>Computer</th>
<th>Human</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>Fast response possible</td>
<td>Delays involved</td>
</tr>
<tr>
<td>Processing power</td>
<td>Large</td>
<td>Limited</td>
</tr>
<tr>
<td>Consistency</td>
<td>Strong for numerical activities</td>
<td>Not reliable: depends on fatigue, training, etc.</td>
</tr>
<tr>
<td>Reasoning</td>
<td>Strong deductive powers</td>
<td>Good inductive powers</td>
</tr>
<tr>
<td>Overload reliability</td>
<td>Sudden breakdown</td>
<td>Graceful degradation</td>
</tr>
<tr>
<td>Intelligence</td>
<td>Limited (expert systems, neural networks)</td>
<td>Considerable: can anticipate and adapt</td>
</tr>
</tbody>
</table>

Table 1: Comparison computer and human in relation to performance (Singleton, 1971)

The behavior of the user regarding to a system from the field of information technologies also depends on how often the system is used. Users handle with a system more or less frequently. Thus, a different behavior of specific users is given. A user, who operates frequently with table sheet software, has another point of view and other expectations in relation to the software. This kind of user will also react in another way regarding to an upgrade or a change of the user interface. This kind of user will adapt faster to a change of software as long as the basic elements stay the same. Users, who interact with given software or systems less
frequently often try to avoid to get conflicted with an update or a specific change. This results from longer learning time due to the low usage of the program or the device (Smith, 1997).

3.5.4 Motivation aspects for the user

As in other areas of work a person wants to be rewarded for a performed task. A reward seen from a psychological perspective means satisfaction and encourages to further activity. In terms of user interfaces, this can be achieved for example by serving small confirmations after a completed action performed by the user. This can be done with the help of sound effects as well as graphical effects. A confirmation of a step provides also a feeling of security and thus creates a more familiar feeling in the handling of the device and its user interface. In general, the user should reach a desired goal within the software as directly as possible. One possibility here is to reduce the structure of the menus. A simple and essential created menu for example makes it easy for the user to navigate. In addition, it also contributes to better clarity. Additionally, minimizing of the response time is another important criterion (Wolff, Kohrs, Scheich and Brechmann, 2006). Short waiting times for opening an application or a saved file allow a smooth work for the user. However, this point can only be influenced by a designer in a limited way. To enable a smooth work process, sometimes also a correspondingly powerful hardware is required. Modern solid state disks for computers, for example, contribute a large part for a smooth work process. Also other hardware aspects like the size of the main memory or the speed of the processor play a major role. For the designer, the avoidance of mistakes during the creation process of a user interface should also be treated without scientific studies as a point with high priority. Nevertheless it should be noted here that unforeseen problems or steps can be very confusing for the user. Especially novice users are affected by those points. Another aspect for keeping up or increasing the motivation level of a user is the nature of the formulation within help or introduction dialogs. Thus, a friendly formulation contributes to the well-being of the user (Shneiderman and Plaisant, 2004 and Ted, 2005).

3.5.5 Avoiding frustration of the user

As already indicated above, a user interface developer should hold on the directive of avoiding errors. Should it come to a program or device failure, it must be explained for the user in a formulation which can be interpreted by the user. Also, this message should contain appropriate steps for a possible solution which helps the user. The user should not feel being lost in case of the emergence of a program error. An error message, which focuses too much on technical details is useful for a technical developer, but not for a user who is not familiar with the technical details of the system. Also here, the formulation is an important aspect: A supporting formulation of the error message gives the user a better sense of safety. A formulation, which dramatizes the appeared problem too much, can cause to weaken the user's sense of safety (Maglio and Kandogan, 2004).

For certain software products or equipment, a training session is unavoidable before the use of the corresponding product. Especially in the business sector with complex software applications it is recommended to point out important operating features of the program for the user. A wrong usage of the software could cause financial damage to the company. A trained user is faster familiarized with the software and thus can contribute faster to the productivity of a company. A user training should not only take place before the initial use of the program, also during the productive use. The user can therefore be introduced step by step to more complex areas. However, for the user training itself, it is recommended to limit the
content of information only to the most important points. The human brain is only able to absorb and to keep a certain amount of information. Thus, it is important to protect the user against a flood of information. Only serving the information which is really needed helps the user to keep the overview and thus also contributes to faster success for the user with the help of the gained knowledge. The latter point is also important for general information dialogues within a certain software application (Nath, 2009).

Another important point, as already mentioned in the previous chapter, is the short response time regarding to user input. If a longer reaction time may still be inevitable, it is recommended to inform the user about a longer waiting time. Additionally, precise information about how long the user has to wait should be implemented. Thus, the user can adjust to the longer waiting period and exclude the possibility of a crash (Shneiderman and Plaisant, 2004).

3.5.6 Feedback for the user

To increase the feeling of safety while operating a user interface, the user must receive feedback for performed actions. This point is also a part of the in this thesis mentioned Shneiderman's Eight Golden Rules. This feedback provides a confirmation for the arrival of the command done by the user within the system. An absence of such feedbacks leads rapidly to the question whether the desired action is performed by the device. Feedback can be made by briefly lighting up a button. Here the user can visually get a confirmation after the button is activated. But a feedback can also be realized as a short sound. At user interfaces for smartphones or mobiles, vibration is used to serve a short confirmation for the user. Thus, the user is able to feel the input. This is used for example when using the virtual keyboard. While creating a feedback reaction for the user interface, the designer should take care of the intensity of the feedback. A wrong designed feedback can lead to confusion (Shneiderman and Plaisant, 2004).

Certain events may require the intervention or the action of the user. These events require special attention. But it should be considered, how the attention for such events is presented. An error message must clearly differ from a warning dialog. The user must be informed of the action which has to be performed according to importance. Within this thesis, possibilities are discussed for these steps in order to alert users regarding to relevant information or dialogues carefully.

3.5.7 Predicting the behavior of a user with flow charts

Flowcharts offer an overview for the developer of user interfaces for one or respectively all possible kinds of program flows. A flow diagram is essential for creating a complex application, as this can contribute to a large extent to avoid mistakes during the design process. This offers to see possible steps the user could do during the active usage of the program. Flowcharts are usually drawn up before the technical development of user interfaces, since the technical developer can use the in theory developed diagram as a guideline. Flow diagrams are also used for internal program processes. Also here they serve as guidance for the programmer and are helpful for the avoidance of errors within the program code. The UML2 diagram was developed specifically for the representation of complex processes and is therefore also suitable for the graphical representation of possible processes within a user interface. UML means Unified Modeling Language and is also used under technical aspects for the development of software products. The UML2- diagram contains
Structure diagrams, Behavior diagrams and Interaction diagrams. In the following, the Activity diagram will be mentioned, which belongs to the family of Behavior diagrams. With the help of the Activity diagram possible paths within one case are described. The Activity diagram consists of the following basic components (Bennet, S., McRobb S. and Farmer, R. 2001 and Matecki, 2010):

- **Black dot**: Is used for the start of the (program) workflow
- **Rounded rectangle**: Within this graphic, an activity is described
- **Decision nodes**: Here, either one or the other path can be chosen
- **Melting nodes**: Puts workflows together
- **Black dot with circle**: Is used for describing the final state of the chosen case

![Activity diagram example](image)

Figure 2: Example of a simple Activity diagram (Matecki, 2010)
Another diagram type, which can be used to predict a user behavior, is the so called *Use case* diagram. However, this kind of diagram is not as detailed as the activity program. The goal of this diagram is to show the steps, which are available with a system, in general. It shows what kinds of use cases are available within the usage of the program. This kind of diagram contains the following basic elements:

- **System**: The system, in which the actions take part. This element is drawn with a square.
- **User**: The specific user, who wants to perform a specific task or a use case.
- **Use case**: The task, which the user wants to perform.

In the following, a simple example of a use case diagram shall be shown. This example shows which steps of a work flow are necessary within the system. The external step is useful for the developer to see that this case is not a part of the system.

![Diagram](image)

Figure 3: Simple example of a Use-Case diagram
3.6 Usability Engineering

3.6.1 What is usability?

Also the term *usability* is defined within an ISO-norm, ISO9241-11.3. The term *usability* is divided into three parts: *Effectiveness*, which describes the way in how precise the user can complete a specific task. Also how exhaustive the user can finish his task is included in this definition. The second part is the *efficiency*, which describes the above mentioned points in relation to the available recourses. The last term which is derived from *usability* is *satisfaction*, which describes the acceptance and the convenience of a system. As already mentioned within this research, the acceptance of a system is an important factor for the success of the software product or a device (Smith, 97).

![Usability Triangle](image)

Figure 4: Usability (Smith, 97)

According to Dumas and Redish (1999, p.4), usability is defined as the following:

“Usability means that the people who use the product can do so quickly and easily to accomplish their own tasks”.

Furthermore, usability has the user as a main factor. It means to understand and to know the user the product will be developed for. This understanding cannot be provided by developers or designers. It is mainly the user who defines if the product has a good usability or not. Usability consists not only of the user interface. Usability is defined by the whole product.

3.6.2 Benefits of adequate operability

A good usability of a program is not only a satisfying aspect for a user. A good usability of a software program also provides important economic aspects. A thought-out designed user interface can contribute to lower costs in many areas of a company. One of the results of such a user interface can be a less effort for teaching purposes regarding to the staff. A user interface which is easy to understand requires fewer training. The last point does not only mean a saving of time, it provides also a cost reduction. Due to an easy usable and easy learnable user interface, the user is also able to focus on his actual work and spend less focus on the usage of the user interface. Thereof, lower costs of a user support during the operational business of the software can be derived. A sophisticated approach requires less maintenance during the operation and thus also contributes to a higher efficiency (Rimmer, 2004; Mankelow, 2006)
3.6.3 How to ensure usability

Usability cannot be seen as an attitude, which can be added at the end of the software development process. Usability needs to be implemented and considered from the beginning of the software development process. Within this process, it is important to meet the needs of the user regarding usability. Therefore, the potential user can be integrated into the design process. A user can be able to test an early status of software and thus provide information about the usability status, which has been reached until yet. Those tests should be done at several stages of the whole process. Within the design and development process also the thoughts of special skilled persons regarding to usability should be considered. This person can be a specialist in the area of user interface design or usability or a manager who knows the behavior of the employees, if the software should be designed for this target group. An information exchange can help to avoid regressions within the design process and thus help to optimize the user interface to the needs of the users. Considering usability at an early stage can help to avoid costs regarding to changes in the later process of the whole project. It helps also to develop manuals and documentation for the training of the users and thus provides a time advantage for the project. Furthermore, it can reduce the effort for updates for the software (Dumas and Redish, 1999).

There are many institutions, which can profit from a good usability. At one point it is of course the user, since the learning time can be reduced by an adequate usability. The user is able to use features with less effort. But at the other hand as mentioned already, it is also the company which benefits from the usability of its products. The company can reduce support and training costs. A product with an adequate good usability can also affect the marketing of other products from the company. Reputation is an important marketing factor for a company. If the reputation of the company can be raised by good usability of a product, this means advertisement for the company in a cheap way (Dumas and Redish, 1999).

3.6.4 Increasing of efficiency

One way to reach an important attitude of efficiency is reducing the complexity. The user interface should be made to provide the user the easiest and shortest way to accomplish a task without any additional steps. Following Heim (2008, p. 200) “Efficiency describes the usability of a design”. An important point to increase the efficiency of a user interface is to keep it simple. A user interface which is easy to understand reduces the workload for the user to understand the user interface itself. This step means at the same way to reduce the features of the user interface to present only options which are really necessary. If further options are required it should be proved if they are really needed in this situation. An optimized user interface should thus be able to predict the behavior of the user and provide information for steps the user could choose. Keeping a consistency within the user interface is another important factor for increasing the efficiency. If a user interface is designed in a consistent way, the user is able to use knowledge from other tasks which were performed with the same user interface to accomplish the new task. Thus, the learning process for the user interface can be decreased (Heim, 2008).
3.6.5 **Measurement of usability**

According to Shneiderman and Plaisant (2004) there are five different ways for an effective measurement of the usability of a user interface. At first the time how long the user needs to learn the functionality of the user interface is essential. Special operations have to be done by the user to create data for the result. Also the speed for completing the tasks is an important point to create a feedback for the usability of a user interface. At third point, Shneiderman and Plaisant (2004) point out the importance of the amount of mistakes, which are done by the user during completing the tasks for the measurement. To go more into detail, the type of the mistakes can be documented. Furthermore, the regression regarding to the knowledge of the user in relation to the usage of the user interface can be observed over a longer time range. The last point, the satisfaction of the user can be used as criteria for the measurement of usability. The last point can be realized by the help of interviews or questionnaires for the user.

3.6.6 **Given software quality standards**

In order to ensure a certain standard of quality also standards were set in this area. These standards shall ensure the compliance with the principle of software quality in terms of user friendliness.

3.6.6.1 **ISO 9241**

This standard was created to set a guideline for the specification for the ergonomics of software. It is not to understand as a purely technical standard, but it provides a guideline with criteria, which should guarantee a specific level of user-friendliness within a user application. This standard must be interpreted and includes the following main characteristics for the usability of software (Oppermann and Reiterer, 1997):

- **Suitability for the task**: This involves the proper functionality of the software compared to the relevant features and functions that are necessary for the user to achieve the goals that are important for the user.

- **Suitability for learning**: This describes the teaching support of the program itself. It defines how the program contributes to understand the program itself and its user interface by the help of included features.

- **Suitability for individualization**: Adapting the interface to the individual needs of the user is defined here.

- **Conformity with user expectations**: This point is to ensure that the user interface is consistent with the expectations of the user. This could affect, for example, the field of work of the user, but also the experience of the user.

- **Self-descriptiveness**: This is ensures the help and support for the user within the program, for example by giving feedback to the user.
Controllability: In how far the user interface is controllable by the user is mentioned within this point.

Error tolerance: This point represents the operability of the program in case of unexpected events. Amongst other things, these events may consist of the incorrect input of a user and program errors.

3.6.6.2 ISO 9126

Another resource for ensuring the usability of software is given by the ISO 9126 standard. Primarily, this standard was created to ensure the software quality in common. But it includes also criteria for the user friendliness of the program in general. This makes it possible to apply this standard also for the designing process of a user interface. The standard includes, amongst others, the following points which are important for designing a user interface (Ho-Won, Seung-Gweon and Chang-Shin, 2004; Anon., 2011):

Fault tolerance: Here, the fault tolerance of the program is considered in general. For the creation process of a user interface, this means the tolerance of erroneous input from the side of the user.

Usability: The effort which is needed to learn the program is in the focus here. Also the understandability of the user interface is a component of that point. Similarly, the general effort which is needed by the user regarding to the operability of the program is mentioned within this point.

3.6.7 Shneiderman's Eight Golden Rules of Interface Design

The so-called eight golden rules (Shneiderman and Plaisant, 2004) provide a summary of other very important criteria in connection with designing a user interface. These rules are based mostly on experience and are not standardized compared with the above mentioned ISO standards. However, they provide an additional foundation for the orientation within the design process. The rules are written for general purposes and may need further adjustment for specific areas:

Strive for consistency: Meeting an estimated consistency within a user interface serves the user a certain standard within various areas of the program. Thus, the user can go sure to meet familiar functions within the program. Thus, this provides a certain feeling of safety for the user while dealing with the user interface. Consistency will be also highlighted by Nielson (1998) in the following chapter.

Cater to universal usability: It should be tried to design a user interface which is suitable for different user groups. This includes for example the availability of shortcuts for advanced users. The last mentioned point allows a faster navigation within a user interface. In most cases, novice users do not feel themselves attracted by available shortcuts and thus, another way for supporting the user in relation to the operability of the user interfaces is needed. An additional graphical assistance given by the user interface can be a remedy here.
• **Offer informative feedback:** For each step, which is performed by the user, there should be offered some kind of confirmation. For advanced users this confirmation should be modest. Therefore, beginners or users who do not deal very often with the upcoming task need a clearer confirmation of the performed action.

• **Design dialogs to yield closure:** Online stores such as Amazon.com, place great emphasis on this point. The user is guided through the purchasing process by the help of detailed dialogues and thus the user is able to see the current stage of the process and in which step the current operation is. This makes it easier to navigate for the user and also provides a certain sense of safety.

• **Prevent errors:** The emergence of errors due to incorrect user input should be avoided from the outset. Hiding of currently not available menu entries is one of the possibilities regarding to this issue. If the user performs an incorrect input, for example by the keyboard, assistance mechanisms should inform the user about the mistake in a user friendly way.

• **Permit easy reversal of actions:** This point is very important to serve a sense of safety for the user in dealing with the user interface. The knowledge of the user about the possibility to reverse inputs leads to further discovery of the program and to a common safer usage.

• **Support internal locus of control:** More advanced users welcome the feeling of having control over the user interface. Unexpected actions of the user interface should therefore be avoided, since they could provide a sense of uncontrollability and thus can lead to discontent.

• **Reduce short-term memory load:** Within this point, a in its base simple hold design is mentioned. This includes also only providing the necessary features within the user interface. The design of very intuitive user interfaces can make an essential contribution here.

### 3.6.8 Consistency as an important factor

Following Nielsen (2002), the also in Shneiderman's Eight Golden Rules mentioned consistency should have a high priority within the development of a user interface. As an advantage for the user, it is pointed out that by the help of consistency the user will be able to transfer the knowledge how to use a specific system to another system or another area within a system. The advantage here is the reduced learning time for the user, but also the fear level of novice users regarding to a new system can be reduced. From a company’s point of view, consistency means also a possibility to reduce training costs. Within a company, a user is thus able to ask a colleague for help, since the software or the device is used in the same way. But also if there would be the case of needed support, the effort here would be low. The support department does not need to train for several use cases and user problems, if there is consistency within the company’s software for the workers. As a summary for the last mentioned points, a higher efficiency for the workers regarding to the work processes which have to be done with the application can be highlighted. Following the software to the roots, a consistency within different applications can also mean reduced support cost for the developer company of the specific software. Following Nielsen (2002), there is no fixed method to
achieve consistency. However, consistency can be defined by several instances which are affected by the product. Also here, standards like the already mentioned ISO standards can be defined within a software product, for example. Such a usability standard can also be set by a higher institution.

3.6.8.1 Negative aspects of consistency

But also consistency provides negative aspects. At one hand, it will be harder for the developers to implement new features without breaking the old rules of consistency. This means a less flexibility within the design possibility for a user interface. A user, which is faced to a user interface or software, which is suddenly inconsistent in comparison to the last product, can get very unsatisfied. But for the company it has another negative aspect: Further technical development should also follow the consistency rules for usability. This means, possibly technical improvements may not be implemented since they would harm the rules for consistency. Also new design aspects may have to be postponed since they could affect the consistency of the product or the product line.

3.6.9 Designing a user interface for a specific target group

When creating software for a specific user group, for example specific departments within a company, the common tasks of the group have to be more closely examined. Similar to the study of individual user behavior, it involves the determination of the activity field of the department, as well as the determination of the operational area of the software. At this point, also the difference between professional users, for example users within a company, and novice users can be seen. Software for professional users can have far more configuration options than software for home users, since enterprise software is used frequently and therefore learned more quickly. Andy Smith (1997) defines the four most common user groups by function: End users, management users, customer users, system users. End users interact directly with the computer system to complete their work processes or private issues. Also, the end user is responsible for the success of given software or a device. Thus, this can also affect the success of a department or company since the acceptance of end users which are in this case the employees, also affects the work performance. In summary, the group of end user needs special consideration while designing the user interface. Manager users benefit from the success of a given system or a software. Within a company, managers have the overview about the efficiency of the work, thus the efficiency of the available software the employees are working with. It is also the manager group which detects the need for new software or a new system. Customer users operate less with a system from the information technology directly. They are touched by inputs or outputs of a system from the information technology. System users belong to the part of professional users. Therefore, they operate and administrate different systems, they are used to handle with a system and can adapt faster to new software or systems. Sometimes, they may interact with software or devices like end users do.

Another way to define a user group is done by sorting the users in relation to their skill level. The easiest way this can be done is by dividing the users into two groups: Beginners and professionals. The difference between those two user groups should be easy to understand. However, a beginner can reach the level of a professional user by a frequently usage of the available software or device. Also, a user who belongs to the category of beginners could be a professional user in another area of the information technology (Smith, 1997).
3.6.10 Evaluate a user interface

Evaluating of a user interface is important, since the user itself provides another point of view for the designer. When evaluating a user interface, the information served within this thesis can be used. Here, it is very important for the designer to perform the evaluating process in an objective way. In general, it is recommended to use the help of a third party for the review. The evaluators should be familiar with the evaluating process to achieve a better result. An assessment can also be done directly by the help of appropriate feedback from the user. For this purpose, for example, the creation of a questionnaire can be helpful. The questionnaire can specifically focus on key operating criteria for the user and thus provide information from the perspective of the user regarding the user interface. Also, an assessment can be done during the operative use of the user interface. Software, which has to be changed permanently, is one example for the usage of such a method. ERP-software is one example for this category, since it has to be changed and adapted to the work flows of the company continuously. An evaluation of an existing user interface is also important for the designer regarding to the design process of user interfaces in the future. Thus, the creator can go sure for being on the right way (Shneiderman and Plaisant, 2004; Dumas and Redish, 1999).
3.7 Graphic Interface Design

3.7.1 Characteristics of colors

The behavior of a user within a user interface can be controlled indirectly through the selective usage of certain colors. However, the use of colors should be done sparingly. Due to an oversized color application, the user can be confused. Also seen from the perspective of arts a not well thought-out color usage can lead to an inconsiderable design. With the proper use of colors, the efficiency of user interfaces can be increased. Here, colors can serve as a guide as well as an orientation. They also can prevent a user from a possible handling mistake. By an error signal in a color which is known as a warning color, the attention of the user can be lead to the problem, which may appear due to the next step the user takes. Here, the color red plays a major role. We know this color from the road and its traffic signs. Red signals us that we need to pay special attention to this sign or to this notice. Other examples are the traffic lights. Here, the color red signals us to stop (Heim, 2008). Also the yellow color can be explained on the basis of this example. It is used for warning notices, for example, in the Windows operating system. The color yellow generally warns against a possible impending critical condition and calls for action from the user. However, green indicates the normal flow of a process. Intervention by the user is not required. Also here, compared with the traffic lights, green shows a normal flow of the traffic. The color white is often seen as neutral and has a smaller role in the design of user interfaces. Likewise the color gray has no special status, but it is often used as a color for a not available menu item in various operating systems (Komischke, 2008; Heim, 2008).

3.7.2 Cultural aspects for colors

Beyond the basic points, mentioned in the chapter above, also cultural aspects play an important role when implementing colors. Depending on the culture, colors can be associated with different meanings and experiences. Also different emotional aspects can be evoked by the usage of colors. But there are not only differences between cultures. The best example here is to ask different persons about the favorite color and the associations with this color. Following Heim (2008), the result will be different associations for a specific color. But also aspects of corporate identity can be a point how people realize colors. One example here is Apple, which is associated by a lot of people with the color white since this color has the attitude of cleanliness and inviolacy. Furthermore, apple is a good example for using colors in their previous marketing strategy. For getting attention of potential customers, Apple used the rainbow colors within the Apple-Logo, since those colors were at that time the symbol of homosexuality. Apple used this aspect to advertise that this company thinks different (Bergère and Kourtchine, 2011).

3.7.3 Correct implementation of colors

By the usage of colors, there are important points which should be considered when designing a user interface. Here, the consistency during the usage plays a major role. The previous comparison of color usage with the colors, available in the road traffic can also be used for describing the consistency. A continuous usage of the same color scheme can avoid confusion and allows the user to quickly respond to a given color. An appropriate sensitivity when using colors can also lead to higher motivation of the user. However, using colors should be done in an economical way. For experienced users, too many colors should not lead to a problem.
However, this can lead to considerable confusion among beginners (Shneiderman and Plaisant, 2004; Heim, 2008).

3.7.4 Characteristics of sound usage within user interfaces

By the use of audio within a user interface design process there are significantly fewer resources available in comparison to the color management. Also, the use of audio has to be done carefully. Not every device has a suitable audio interface. The use of audio in user interfaces, which fit into the category of this thesis, usually represents only an additional feature. The use of audio is used primarily for getting the attention of the user. However, if an appropriate audio interface is available audio can be used to get additional user attention. An error message may be equipped with a clear warning sound whereas a simple notice message should be provided with a more mellow tone. Like with the usage of colors, the use of audio during designing a user interface should be done in a way to avoid the confusion of a user. Thus, also the aspect of the economical implementation applies here (Rauterberg, et al., 1995).

3.7.5 Look and feel: Usage of vibrations

With the introduction of mobile devices, smartphones for example, new possibilities were available to lead a user through a user interface. By the help of a small-scale vibration of the device, the user can feel the current state of the device. The vibration is used here mostly for confirming of an action or in greater measure to get the attention of the user, for example in the case of an incoming call.

The usage of vibration has already taken place in the world of electronic entertainment. The 1997 introduced video game console Nintendo 64 from the same named company Nintendo was able to create vibrations by the help of the so called Rumble Pack. This device was available as a plug-in device for the controller of the console and was used for confirmations of actions, done by the gamer. The use of vibration is very limited since they only can be varied in a small degree. However, also here, economical use should be considered to avoid to confuse or even to frighten the user (Cha, Orozco, El Saddik and Eid, 2011).

3.7.6 Designing a user interface for a specific device

A user interface cannot universally be created for each available device. Each device has specific characteristics which require a special user interface. In the following, different variations of devices and their important aspects for the development process of a user interface for the devices are presented.

The successful story of today's desktop computers began in 1964 (Bleicher, 2008), in which the first operating system for a usage with mouse and keyboard was developed. A little further in the future, the first desktop computers, amongst other things, the Apple I and Apple II were sold. The possibilities, which were available by the help of the desktop computer, were growing steadily since that time. Especially the emergence of the Internet and the overall global networking contributed to the more growing success of the desktop computer. Today, this type of computer can be found in many areas of our everyday life. This includes our own home or our workplace. The computer has become an integral part of everyday life. With the help of computers it became possible to write texts, correct, and bring them first on paper after reaching a satisfactory level of the written content. Today, the computer offers us more
opportunities, especially in the field of communication. For the usage of a computer, usually a keyboard, a mouse and a screen is needed as basic equipment. The advantages of the computers which are available today are the high technical performance as well as the possibility to present contents on a wide screen. The latter refers to a comparison with the mobile notebook, which is discussed later within this paper. The desktop computer is not designed for mobile use. When designing a user interface for a desktop computer many options and opportunities are available. Due to the availability of keyboard and mouse a large amount of control options can be used for a user interface. For experienced users for example, it is thus possible to create shortcuts for applications, which allow the waiver of the operation with a mouse. This allows a faster operability for advanced users within the user interfaces (McElhearn and McFarland, 2004) and thus this leads to a higher level of motivation. Also today's desktop systems provide a larger screen resolution, which for example makes it possible to place more menu items within the user interface. The creator of a user interface for a computer can also go sure that it will not be designed for mobile usage. A desktop computer typically has a fixed location and is therefore as mentioned above not designed for mobile use. In general, there are more design possibilities available when creating a user interface for a desktop computer compared with a design process for other devices. But also here, the economic and intelligent use of the given possibilities is essential.

A notebook has been designed, however for mobile use. The term notebook was introduced for marketing purposes by Toshiba in the 80s. In its origin, a notebook has been primarily designed for mobile use but its more and more used as a desktop replacement (Parbel, 2008). Notebooks are similar to the architecture of a desktop computer, therefore the design concepts can be compared with some trade-offs. Notebooks also can be found in a large amount in the business sector.

A notebook usually has not the same performance as a desktop computer, because mobility is an important point here and low performance components require less energy. The usage of a notebook is similar to the usage of a desktop computer. Only during the mobile usage the use of the touchpad is required. Here, a mouse-like navigation with reduced speed is possible. As notebooks are as already described similar to the desktop computer architecture, a similar approach is recommended for designing a user interface. Also the application should be compatible for usage on a desktop computer. An exception is the Apple MacBook, which makes it possible by the help of Apple's so-called multi-touch function to operate with multiple fingers on the touchpad. Here, the operation methods for Macbooks are extended with so-called gestures. Depending on which gesture combination done by the user is detected, the specific action will be performed. When designing a user interface that allows thus increased possibilities regarding to the usage of the user interface.

A tablet computer is different from the last-mentioned device families. A tablet computer is primarily focused on the use of multimedia content. A tablet is equipped with a special for this device adapted operating system and therefore requires a less powerful hardware base. Here, it is also essential to consider the guidelines published by the manufacturer regarding to technical details. A user interface for an application for a tablet computer is completely different from the development of a user interface for a desktop computer or notebook. A tablet is directly controlled via the touch screen and thus has no mouse or keyboard. Since you can operate the user interface only with the human fingers by direct contact of the touch screens, this is also an important point which must be considered. A Tablet is designed for mobile usage and therefore has limited energy resources. Therefore, during the design process the limitation of the available resources within the device must be respected. From the
technical point of view, this means to optimize the computation-intensive mechanisms (Subramanya and Yi, 2006).

Similar to the usage of a tablet is a smartphone. A smartphone offers the advantage to unite several functions from a lot of different other devices within one device. It includes the ability to make calls, but also the possibility to receive information from the Internet is available. Compared to the Tablet, the screen of a smartphone is designed in a smaller size. As with the Tablet, the possibility of installing applications is available in case the basic functions of a smartphone are not sufficient. Other important aspects are the mobility of a smartphone and the ability to use the device for multimedia applications. The criteria for creating a user interface are similar to those from a Tablet PC. However, also here the in comparison to the notebook or desktop PC weak hardware has to be considered. As with the tablet a smartphone is constructed for mobile usage, which also means to construct applications with an effective energy management. The operation of newer smartphones is also done mostly by the help of a touch screen. The screen size is compared with a Tablet very small, thus the menu structure of an application should be kept in a thin size. This helps an overload of the screen and thus to avoid confusion of the user (Subramanya and Yi, 2006).

Another device, which will be discussed within this thesis, is the mobile. The mobile can be seen as the precursor of the smartphone. The mobile is designed primarily to make calls, but over the time it has been equipped with additional functions. But compared with a smartphone, the functions of a mobile provide fewer features. Like with a smartphone, the mobile provides the opportunity of sending short messages. However, this is seen as a secondary important function here. One of those functions is the possibility of sending short messages (Shneiderman and Plaisant, 2004). Short messages are limited to 160 characters per message. This limit still exists today but however, it can be bypassed with the help of combining several short messages to one large message. After the program interface Java Micro Edition (Java ME) was introduced in 1999 (Ortiz, 2004), newer generations of smartphones were able to install Java applications. A mobile has a very small display and only some devices serve the possibility to use the device via a touch screen. Therefore, only a numeric keypad for the input is available. Due to the small screen also the spectrum of information that can be displayed on the screen is very limited. For the designer of the user interface, this means to display only information which is really needed. Added to this a possible limitation of the number of colors which can be displayed by the device must be considered (Subramanya and Yi, 2006).

3.7.7 Possibilities for a user interface by the help of input devices

The most well-known input device since the introduction of the desktop computer is still the keyboard. This input device is used primarily for entering text. But it can also be used for entering commands for actions the computer shall perform. The 10-finger writing system allows faster text input. Due to country-specific special characters or letters, the arrangement of the keys can differ. But this does not affect the basic functions of a keyboard.

When designing a user interface, which is primarily designed for use with a keyboard, the input method can be made easier by implementing shortcuts (McElhearn and McFarland, 2004). But it should be sure that these shortcuts cannot be triggered by untrained users accidentally. A good opportunity here is the usage of shortcuts in combination with standard function keys, such as the CTRL or ALT keys which are available at most today’s IBM standard keyboards. Additional opportunities for the execution of special orders offer the F-
keys which can be found on the top of the keyboard. Notebook keyboards often also provide so called hotkeys. These are equipped with notebook manufacturer-specific functions and are generally not available for other applications. Especially for experienced users, the keyboard offers the opportunity to make inputs faster. For professional users, the so called mnemonics offer a faster selection method by selecting a menu entry with available key combinations. This also creates a small speed advantage in comparison with the mouse as input device.

The in the year 1968 (Grossman, 2007) introduced computer mouse was designed as a kind of spare hand for the direct input within a graphical user interface. Thus, the user was able to adjust the speed of the mouse pointer to the own needs. Depending on the available mouse keys, the developer could perhaps be restricted in using them. While mice made for computers which are designed to operate with the Windows operating system provide at least two mouse keys, the official mouse for Apple computers provides only one key. In addition to these buttons, the scroll wheel has been developed. By the help of the scroll wheel, is possible to allow the scrolling within window based applications. Depending on the manufacturer of the mouse, the scroll wheel can be used as a third mouse button.

Another development in the mouse control is the use of so-called mouse gestures, which was invented in 2000 by the Norwegian company Opera Software ASA. Here, the application identifies the currently executing gesture and then performs the desired action. One advantage of mouse gestures is the speed: A mouse gesture is performed faster than finding and pressing the action with the help of the normal mouse operation.

A disadvantage of a gesture is the lack of finding the available mouse gesture in a visible way. In comparison with an available push-button, the mouse gesture cannot be seen. Thus, mouse gestures provide an additional way of operating a user interface, especially for advanced users.

![Figure 5: Using gestures with the Opera Web Browser](image)

From the previous mentioned input devices, the touch screen is different in its operation for a user interface. A touch screen is mostly used in smart phones and Tablet PCs. In other areas, for example in the medical field, touchscreens are also used for the operation of special
medical devices. A touch-screen gives the user the feeling of being able to manipulate the device directly, since there is no need to further control devices. A touch screen is operated only with human fingers and thus requires a different operational concept as for example a device with a keyboard and mouse. In contrast to the operation with a mouse a finger is not as precise as a mouse for controlling a touch screen interface. This means for the designer to create bigger icons for the controllable parts of the user interface instead of using small icons, optimized for a mouse pointer. A touch screen also allows the usage of multi-touch gestures. By the help of those, a desired reaction of the application can be performed by using more than just one finger during input. Some of the known functions, for example, are enlarging text or rotate images. The disadvantage of this type of operation is the restrictive possibility of text input. The touch screen can indeed be used as a virtual keyboard, but especially for users which use the 10-finger system, it does not provide the same speed for text input as the normal keyboard. One way to counteract this is the guessing of the word by the system which the user wants to enter. After entering the first characters of a word, several word suggestions are provided for the user. Thus, entering all the characters for completing the word can be skipped sometimes. This also serves an advantage regarding to the input time (Waloszek, 2005).

A similar control concept pursues the T9 input possibility, if the input device has only a numeric keypad. The T9-concept was designed for a usage with mobile phones. A numeric keypad restricts the input options in comparison to a keyboard. Thus in general only the numbers 0-9 and the characters * and # are available. T9 assigns each of the existing numbers with a selection of letters, thus allowing the input of text. The disadvantage of T9 is that only well-known words can be suggested. To counteract this, T9 systems today have the ability to learn. This means, if the word is needed again at some point, it will be then suggested by the system if the digit combination matches. When creating a user interface for a device with a numeric keypad, the designer can rely on the use of shortcuts to make the operation of a device more comfortable. Mobile phones have usually also a kind of pad or something similar to allow additional control options (Schiessl, 2002).
3.8 Summary of theoretical findings

In the following the theoretical study will be summarized. This will be accomplished by answering the affected sub-questions:

Which options are available to help leading users through a system?
For guiding a user through a system a point of view from the perspective of the user is necessary. The developer must design from the position of the user and thus be able to predict the behavior of a user. This can be done for example by the help of UML2 sequence diagrams, such as described in this thesis. Using these charts allow to create behavioral processes of users and thus adapt the user interface.

What are important design principles for increasing the usability of a user interface?
When designing a user interface in terms of efficiency and usability only relevant elements should be used. This means that the user interface should only perform tasks for which it was primarily developed in theory. Other options, as well as additional features can contribute to the confusion of a user. Another point regarding to usability is the consideration of Shneiderman’s Eight Golden Rules of Interface Design. These rules contain arguments, which can increase the usability of user interfaces. Even the consideration of the ISO-Standards represents an important tool in terms of usability of user interfaces.

Which aspects are important when designing a user interface for a specific device?
Here technical aspects of the device are important. When designing a user interface for an existing device, the given hardware must be considered. Guidelines from the manufacturer of the device provide important information here. A user interface, which has high hardware requirements can lead to complications during the operational use. Among other things, slow response times can be the result. This in turn can lead to confusion or even frustration of a user. For the further design process also the available input devices have to be examined more closely. A touch screen requires a different approach than the traditional user input by keyboard and mouse.

How is it possible to avoid creating barriers for the user while designing a user interface?
Here again, the ISO standards and the development with the use of flow charts play a major role. Especially with the help of flow charts the steps which are necessary to achieve a specific menu item or activate a specific option within the program, can be shortened. Color theory also plays a role in this issue. The selective use of color can contribute to a better transmission of information to the user. With the help of colors we can draw the user’s attention to certain information. Already existing (color-) patterns, which the user knows from other areas of life, can be used for a better navigation within dialog messages.

How is it possible to avoid an information overflow and thus confusion for the user?
The information which is shown to the user, should not deal with technical details, as those in most cases cannot be understand by the user. Additionally, simple text formulations of the dialog messages are important. To keep up the motivation level of a user, it is also necessary to pay attention to kind formulation of the text. Also here, the amount of the information which is presented to the user is important.
3.9 Arguments for an empirical study

Within the theoretical part, given information and data from theoretical studies and articles were used. With the help and the possibility to interview an experienced software developer in the field of user interface design, the theoretical part shall be reaffirmed. Another argument for the empirical study is the actuality of information in the area of information technologies. Thus, data from an actual point of views shall be served for this study.
4 Empirical Study

4.1 Purpose

The main purpose of the empirical study is to verify the findings from the theoretical chapters. Therefore, the empirical study shall provide a point of view in relation to user interface design from a user interface designer, who is directly affected with the topic of this research. For this thesis, the interview was selected to get a closer look behind the scenes of a user interface designer, working for Opera Software ASA. After the interview, the answers will be analyzed to get a relation between practice and theory.

4.2 Sampling

The contact with the person for the interview was made by the help of another employee of the mentioned software company. The person for the interview is currently working abroad. Due to the remote location and the limited time of the user interface designer it was decided to carry out the interview via e-mail. By this way a larger and more flexible period shall be served to the designer for answering the questions. Another objective was to avoid rush and thus receive more relevant information for this topic. Since I am working as an intern within the company, the structure of the company was known to me. Thus, I was able to ask my colleagues directly about a convenient person for the interview. As a summary, this method can be called a convenience sampling method.

4.3 The interview

The preparations for this interview were done parallel to the process of the theoretical part of this thesis. The questions are based on the theoretical part of this thesis for getting a direct comparison between practice and theory. The interviewee is responsible for the user experience within Opera Software ASA. Thus, the person is responsible for the strategic product development and the pipeline production of software products. The team, for which the person is responsible for is a combination of graphic designers and interaction designers with various background information. Within the design process, aspects from marketing, engineering, product strategy management and feedback from the users are included.

A new design process for a new user interface depends often on design issues from earlier versions. It is also necessary to consider strategic and marketing decisions when creating a new user interface. For a new concept for a new user interface, a workgroup which consist of the product management, the user experience and graphic designer team and software engineers are brought together to develop a new user interface design. Within these discussions, new suggestions are presented in different ways. It can be just concept or a specification which should be respected within the new user interface. But also limitations for the process will be pointed out. This discussion takes part within frequent intervals to guarantee synchronization between each team.

Regarding to forecast possible steps of a user, amongst others, the following techniques are used within the design process:
Writhe-through: This method is also known from the design process for cars. The intention of this concept is writing a text regarding to already existing experience or particular characteristic about a product. This text can include experience with the atmosphere, the celerity or the feedback when activating or using an option or something equal. The background of this process is to see the design process from the point of view of a user. In addition, some user experience is presumed.

Questioning & Answering: This method was described as more objective. The way this method can be applied can be different. At one side, it can be done within a discussion, at the other hand it can be written down on a paper. A question is asked which steps and why a user could try something within the program. This question is formulated from the point of view of a user. The answer is then given by the user interface. If enough questions are collected, an idea can be created regarding to issues which should be treated with high priority within the design process. On the other way, this can also lead to a conclusion to avoid making a specific option accessible in an easy way which addresses then only advanced users.

Wireflows: This technique is also used to predict possible steps of the user and the results. Similar to the within this research mentioned flow charts, this technique includes the whole user interface as a part of a diagram. This user interfaces is drawn as a wireframe to reach a better overview. Also information about the program flow is added within this drawing. Also here, the goal of this technique is to get a point of view from the user and to find out what option or what button could be activated and why this step could be done by the user.

For giving feedback to the user during the use of the user interface and providing an easy usability, the within this thesis mentioned aspect as less as possible, as much as necessary is used. An example, mentioned within the interview, is the way of giving answers to actions performed by the user. For the optimal way of this kind of feedback, only one answer should be provided to the user. Exceptions are, for example, important questions which can affect the data the user is working with. Also visual feedback is an important option to provide a feedback to the user regarding to the performed actions. As an example, small animations are mentioned here. Also sound feedback can be used for confirming an action done by the user.

The usage of colors within the design process for a user interface depends often on different factors. At one point, the designer has its own preferred colors. But also other decisions, made by other designers have to be considered. Also marketing issues play an important role regarding to the color usage. Another important factor regarding the usage of colors is the platform the software will be designed for. Some platforms have color conventions, which also have to be respected.

Regarding to specific rules for the design of a user interface and the usage of official standards, it is important to know the guidelines which are available for a specific platform. But guidelines are not obligatory; a designer must be able to break those rules if necessary. Also usability guidelines should be considered when designing a user interface. Especially for products from Opera Software ASA, which are available for a wide range of platforms, it is essential to start the design process for a user interface with the goal to create a formable user interface for a small screen size.

When designing a user interface for specific devices, it is tried to create a user interface, which can be used also with other devices. Thus, the user interface should be variable in its
size and adapt itself to a given screen size. This user interface works then as a basic user interface, which can adapt itself to a specific screen size or other attitudes of the device.

Receiving feedback from the user is an important factor within Opera Software ASA. User feedback can be received by the help of simple observation methods or by comments, provided from the users directly. For this purpose, also social networks like Facebook or Twitter are used. However, the feedback given from a user directly must be interpreted sometimes. But also colleagues within the company can serve useful feedback regarding to a product or a user interface and its usability. Since the company is an international company, thus it is also possible to receive information from different countries.

Common important design aspects for the interviewee are at first to try every given possibility to see the results before finding a final course for a user interface. Another important aspect mentioned is to encourage the user to expand the possible options of a user interface. Thus, it should be possible for the user to expand the software for the own needs instead of disabling a too large amount of given options. One reason for this step is to avoid confusion for a novice user, but provide extra features for an experienced user at the same way. But also design issues are one point for this step. A clear and not overloaded user interface is the result of this step.

4.4 Empirical research results

For this chapter, the information served by the interview will be used. Within the interview, important procedures for the design of a user interface were mentioned. Common aspects of theoretical user interface design aspects which are mentioned within this research are used. However, also new techniques were presented. To extract the information, included in the interview above, the received data will be elaborated by providing answers for the affected sub questions.

What are important design principles for increasing the usability of a user interface?
At one point, it is important to receive feedback from the user directly. This helps to understand the problematic from a direct user perspective. This feedback can be received by the help of observations or by direct contact with a specific user or user group. However, the last way means to rework the feedback from a user in some cases. It is also important to provide feedback for the user and thus provide a confirmation for an action done by the user. Also predicting the steps of a user is an important factor for reaching a high usability for a user interface.

Which aspects are important when designing a user interface for a specific device?
While designing a user interface for a specific device, it is important to know the platform specifications and guidelines. However, these guidelines are not obligatory. It is the decision of the designer to follow these guidelines or not.

How is it possible to avoid creating barriers for the user while designing a user interface?
Official usability guidelines should be considered when designing a user interface. Also here, predicting the behavior of a user by the help of the in the interview mentioned wireflow technique, for example, can provide support here.
5 Analysis and Result

Within this chapter, an analysis for the collected data shall be provided. Also a comparison between the theoretical study and the empirical findings shall be pointed out.

5.1 Analysis

The Analysis will be done by answering the sub-questions with the help of the theoretical as well as the empirical part of this study:

Sub Question 1: Which options are available to help leading users through a system?
Following chapter 3.5.5 and 3.5.6, one important aspect for this point is to help the user by providing feedback. By the help of providing feedback, the user is thus able to know that the system has received a specific command, given by the user. This helps also to show if a step has been performed correctly or if more input from the user is necessary in order to complete the desired action. There are several options available to provide a feedback for the user. Providing feedback can be done with text, symbols, sound or even vibration. When implementing feedback mechanisms, it is important to avoid a confusion of the user. Especially for novice users, this is an important aspect. A feedback information message should also not include too many technical details, since the user is in the normal case not familiar with the technical aspects of the system. As mentioned in chapter 3.5.7, by the use of flowcharts it is possible to predict possible steps the user could perform. This makes it possible to optimize the user interface, following the flow chart. The flow chart also helps to limit the possible options and to find out which options are really needed. Therefore, it is possible to put options together or limit menu entries. Described within 3.6.3 and confirmed by the empirical study, another possibility to optimize a user interface regarding to the needs of a user, is the user itself. By the help of the user, the developer can get a point of view from the user side to predict the behavior of a user in a better way. This also helps to respect other behavior aspects of the user regarding to a system. Thus, it is not only possible to prevent confusion of the user, this also provides the possibility to add more features the user needs for accomplishing a task. Here, is also important to consider the target group the user interface is designed for, as mentioned within chapter 3.6.9.

Sub Question 2: What are important design principles for increasing the usability of a user interface?
Chapter 3.6.6 points out, that there are already standards available, which shall ensure the usability of a system or software. ISO 9241 is a special standard for describing guidelines between human and computer. This standard does not provide fixed information; it is more a standard that has to be interpreted by the developer. Also ISO 9216 provides information, but especially for the whole process of the software development. But also within this standard, useful information regarding to the design process of a user interface can be found. This standard does not provide fixed information; it has to be interpreted by the designer. Aside from the official standards, chapter 3.6.7 describes quasi-standards for providing usability for a user interface design. One example here are the so called Eight Golden Rules of Interface Design, developed by Ben Shneiderman. Those rules are based on experience and also have to be interpreted with a heuristic approach. They have to be adapted on specific design issues. Chapter 3.6.4 points out more important aspects: Only providing elements which are needed for accomplishing a specific task help also to increase the usability. Fewer elements mean a lower possibility to make a mistake during the operation with the user interface. This allows
finding a specific option in a faster way which provides a pace advantage for the user. For increasing the usability of a user interface, also as mentioned for sub question 1, the providing of feedback is an important aspect. Thus, the user can go sure that a task or an action has been accomplished correctly. Also here, receiving feedback from the user can be essential. The user provides important information, which can be used for improving the efficiency of a user interface. Following the empirical results, this information can be collected in different ways. One way here is the collection of relevant data via social networks, like Facebook. It is important to stay in contact with the user to meet the needs of the user. The last point is also essential for the evaluation of the user interface, as described in chapter 3.6.10.

**Sub Question 3: Which aspects are important when designing a user interface for a specific device?**

Following the results of the theoretical study in chapter 3.7.6 and the empirical study, it is essential to know the hardware the user interface will be designed for. This goal can be reached by considering the platform specifications and the guidelines, which are available from the manufactures of the device or the hardware. If those guidelines will be ignored, this can easily lead to malfunction and user frustration. Furthermore, the area in which the device or the software will be used needs to be examined. Here, chapter 3.7.6 points out differences between a mobile usage and a fixed usage field. A user interface for mobile devices should be designed for less energy consumption. Also the available screen size has to be considered here. When designing a user interface for a specific device, the available input devices have to be considered. Here chapter 3.7.7 points out different approaches which are needed when considering the different available options regarding to the input device.

**Sub Question 4: How is it possible to avoid creating barriers for the user while designing a user interface?**

Also within this point chapter 3.5.7 describes the usage of flowcharts which help to predict a possible user behavior and thus help the developer to avoid creating barriers, for example in terms of an unstructured menu. Another important issue from the theoretical part of this study is the consideration of the ISO-standards, mentioned within chapter 3.6.6, regarding usability, user interface and software design. Those standards, which have to be interpreted, provide information how to assure usability and thus, how to avoid creating barriers for the user while using the interface design. As highlighted in chapter 3.6.8, keeping one standard within the whole software or user interface project can help to simplify the operation for the user. Consistency also allows a faster learning how to use the user interface and thus it provides a higher motivation for the user at the same time. The chapters 3.7.1 till 3.7.3 point out important aspects: Given color theories and the economic usage of them can contribute to consistency. They may also help the user to navigate through the system or to get the attention of the user regarding important information or if further input is needed from the user. Here, well known colors such as warning colors can be used for putting the user’s attention regarding to the system information into the right direction.
Sub Question 5: How is it possible to avoid an information overflow and thus confusion for the user?

Detailed described in chapter 3.6.4, one important issue is to avoid too many possible adjustment possibilities within the user interface. The goal of the user is to accomplish a specific task with the help of the system. Thus, an information message which cannot be interpreted by the user can lead to frustration. Here, it is important to provide options which are helpful for the user and, in case of a problem, can lead to a solution of the problem. If possible, only one feasible answer possibility should be provided when giving a feedback to the user. This helps to avoid a confusion of the user. Following the empirical as well as the theoretical results, official usability guidelines contain important information regarding to the design process of a user interface. They should be respected, if possible. However, following the empirical results, a designer should know when a guideline should be respected or not.
## 5.2 Result summary

The summary will be presented by the help of a table. Within the research process, several aspects in relation to the design of a user interface were pointed out. These results may answer several research questions together. The key information which is provided by those answers can be defined as *design principles* for reaching a *good user interface*:

<table>
<thead>
<tr>
<th>Design principle</th>
<th>Description</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feedback</td>
<td>Providing feedback for the user during the operation of the user interface</td>
<td>Orientation for performed actions, provides safety feeling within the navigation, increases the usability of a user interface, thus contributes to a better human-computer communication</td>
</tr>
<tr>
<td>Simple feedback</td>
<td>Avoiding technical information within the feedback, keeping the feedback simple</td>
<td>Better understandable for the user, helps to navigate faster within the user interface, information overflow can be avoided</td>
</tr>
<tr>
<td>Flow chart usage</td>
<td>Usage of flowcharts within the development process to predict the behavior of the user and simplify the structure of the program</td>
<td>Shows possible options to simplify the steps it takes to reach a specific action, helps to optimize the program flow, helps to implement faster navigation possibilities for the user, helps to avoid barriers for the user</td>
</tr>
<tr>
<td>User’s point of view</td>
<td>Getting a point of view from the user to predict the behavior of the user, usage of feedback received from a user directly</td>
<td>Provides important aspects and information from the perspective of a user, provides possibilities to optimize the user interface for the direct needs of a user, shows information which only a user can illustrate, helps to point out barriers within a user interface</td>
</tr>
<tr>
<td>ISO-Standards</td>
<td>The usage of given official standards like ISO 9241 and ISO 9216</td>
<td>Basic level of software quality can be reached, standards provide aspects regarding higher quality for usability and operability</td>
</tr>
<tr>
<td>Shneiderman’s Eight Golden Rules</td>
<td>Considering Shneiderman’s Eight Golden Rules of Interface Design</td>
<td>Rules based on experience and the author’s knowledge, higher level of quality can be reached, since rules were developed and adapted over the time</td>
</tr>
</tbody>
</table>

Table 2: Design principles
<table>
<thead>
<tr>
<th><strong>Design principle</strong></th>
<th><strong>Description</strong></th>
<th><strong>Purpose</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Keeping it simple</strong></td>
<td>Only relevant elements should be used for the design of the user interface</td>
<td>Time to understand the usage of a user interface can be reduced, user mistakes can be reduced, thus a higher usability in relation to effectiveness can be reached, further an information overflow can be avoided</td>
</tr>
<tr>
<td><strong>Consideration of platform guidelines</strong></td>
<td>Considering the platform specifications and guidelines regarding to technical details of the device the user interface will be developed for</td>
<td>Malfunction because of hardware aspects can be avoided and therefore user frustration can be avoided and a higher performance of the user interface can be reached</td>
</tr>
<tr>
<td><strong>Area of usage consideration</strong></td>
<td>Considering the area in which the platform is used</td>
<td>User interface can be optimized for this area, important differences for mobile and desktop usage can be considered</td>
</tr>
<tr>
<td><strong>Consideration of available input devices</strong></td>
<td>Consideration of the available input devices and thus optimize the design of the user interface</td>
<td>User interface can be optimized regarding to specific input possibilities, malfunctions and user frustration because of wrong input can be reduced</td>
</tr>
<tr>
<td><strong>Considering of consistency</strong></td>
<td>Considering consistency within the whole design process of the user interface</td>
<td>User is able to use the same knowledge in different parts of the user interface, helps to reduce the learning time for the usage of the user interface</td>
</tr>
<tr>
<td><strong>Selective usage of colors</strong></td>
<td>Selective usage of colors and color theories can help allowing a better navigation within the user interface</td>
<td>Already known color theories can help to get the users attention, helps that the user reacts in an appropriate way to user feedback</td>
</tr>
<tr>
<td><strong>Limitation of available answer options</strong></td>
<td>If possible: Only one possible answer choice should be provided for the user</td>
<td>Avoids confusion for the user, helps to provide a fluent usage of the user interface since the next step is clear defined</td>
</tr>
</tbody>
</table>

Table 2: Design principles
6 Discussion

Within this chapter, a final discussion about the analysis of the data as well as the resulting outcomes is made. Also, an evaluation about the research process should take place. Another point within this chapter will be a discussion about possible implications for informatics. The chapter will be concluded with possible views for the future.

6.1 Conclusions

During the research several approaches for an appropriate user interface design were considered. Depending on the software project or on the specific device, several specifications and guidelines must be considered. It is important to meet the needs of the user in case of usability since this is an important aspect for the success of the user interface respectively the product developed of a company. For the consideration of the needs of the user, it is important to get a point of view from the user. Here, several design techniques provide a clue. With the help of this perspective, it is easier to implement new features since the behavior of a user can be predicted and thus mistakes regarding to usability can be avoided. It is also important to include user into the whole design process since the user can provide important information from his direct point of view. But also given standards regarding to user interfaces and usability provide principles for a user interface. For the user interface itself, amongst others, one important design principle is to keep a consistency within the whole design process. Consistency allows the user to use similar principles regarding to the usage of the user interface design for the whole user interface. It is also important to provide feedback for the user since the user can go sure the input given by the user will be performed.

Within the empirical study, theoretical findings were acknowledged. However, the empirical study pointed out some more techniques which are helpful for the design process of a user interface. Also decisions from other departments within a company must be respected for the whole design process. Here, for example, marketing and other important strategic decisions are important. This also affects the usage of colors regarding to marketing decisions. The empirical study pointed out important points for the design of user interfaces in the area of web browsers and web browsers for mobile devices.

By the help of this investigation important aspects for designing a user interface have been highlighted and thus contributed to get a feeling and an understanding for designing a user interface. Despite the rapid aging of the information in the field of computer science certain basic principles still remain in relation to the theoretical design process of a user interface. Respecting those aspects makes it easier to bring a new device closer to the user. The design process of a user interface should be tailored on the user itself, it is also important to respect the given hardware criteria of the selected target device. By using the criteria, which is described within this thesis, also a higher user motivation can be created. A satisfied user in the economic sector means higher efficiency and therefore lower costs. In common, time and costs can be saved by a correspondingly in the theory well-developed user interface.

By the help of this research, guidelines on which the designer of user interfaces can follow were created. Developing a user interface in theory is also an important factor from the technical point of view. Given hardware components are often limited in their performance and thus, a theoretical approach can help to avoid problems from the technical side.
Especially the last mentioned point is the case within the sector of mobile devices. Also in this sector users are addressed who have not had much contact with information technology until yet. With the growing use of smartphones and tablets, new challenges arise for a designer to simplify the usage of a device and thus allow less technical experienced users to take part at the new mobile way of communication. With the help of appropriate tools and charts, which were mentioned in this thesis, the user’s behavior can be simulated by the designer. This also means a cost reduction in the development phase, thus the user interface can be directly tailored to the user and his needs.

6.2 Implications for informatics

In the field of computer science the results of this study provide the possibility to create a better human-computer interface. For the user, a simplified usage of a device means a boost of motivation and thus a simplified operation reduces the barrier between man and machine. In common, a simplified usage, provided by a simple and in the theory well developed user interface should reduce the technology hostility of many users.

From the perspective of a designer, this study can lead to a rethinking of the theoretical development of user interfaces. With a corresponding adjustment of the design process by integrating the aspects listed within this study a better user interface could be achieved. Seen retrospectively, this also can contribute to reduced costs as additional improvements after the release of the product in relation to the user interface and the usability can be reduced.

6.3 Method evaluation

This study is based on already existing studies for different topics. Relevant information regarding to this issue was used from previously published studies, articles and academic books. Also information was collected from studies that did not have this issue as a backdrop. Anyway it was possible to serve an important part for this thesis by the last mentioned source of information. The Internet also was used for the collection of data, since it includes scientific articles with valuable information, available from the database of the Högskolan i Borås.

For the interview, a qualified employee, responsible for user interface designs and working for Opera Software ASA was chosen. This interview took place over the Internet via e-mail correspondence. The workplace of the interviewee was not located Sweden. Thus, it was not possible to lead the interview in person due to time and cost reasons. Anyway, the answers and the information received by the interview included important aspects from the designers’ perspective of view. Therefore, it contributed important parts for this research.

It was also considered to ask users directly about their needs in relation to a user interface. But during the creation process for the questions, the difficulty for formulating a question in a not to technical way appeared. Also, it was not sure that the answers provided by the users were answered correctly since the user can interpret a given problem in another way. The last mentioned point is supported by my own experience as a worker responsible for the first-level-support. As a conclusion, a direct survey for users was canceled.
6.4 Result evaluation

For validating the result, as mentioned in chapter 2, triangulation was used. Triangulation includes, amongst others, method and data triangulation. In the following, it will be described how both of those Triangulation methods were used:

- **Method triangulation:** For this research, more than one method was used to gather the required data. On the first side, it was the collection of secondary data by the help of given literature. These data was used for the theoretical part of this study. As a second method, the collection of primary data was used in order to compare and validate the theoretical findings from a developer’s perspective of view. This triangulation method was used since the theoretical findings could differ with the ways how this knowledge is applied in practice. Also it was important to get a current point of view to compare in how the theoretical data is still up to date.

- **Data triangulation:** Especially for the collection of secondary data, this triangulation method was used. The data for the theoretical part was collected from scientific articles as well as from academic books and the Internet. This triangulation method makes it possible to validate and compare the data with the help of different sources. Taking the data from different sources also offer views from different authors. Here, it depends what relation the author has to the research and thus, it is possible to receive different point of views. Also the different approaches from the authors made it possible to compare the results with each other.

6.5 Possibilities to generalize

This study can be used for many areas, which have the goal to design a human-machine interface. Many aspects mentioned in this study can be used for other classes of devices than those described within this thesis. Depending on the system, possibly more detailed adjustments are necessary since this study only provides basic aspects for the design process of user interfaces. Also for the creation of websites, this study is suitable in some sense. A website can be seen as a kind of user interface, since it allows the user to navigate within the website to reach specific information or order an article over the internet.

6.6 Ideas for continued research

This study only provides basic principles for the creation of a user interface. Further studies could include the precise psychological behavior of a user. Also providing more information about technical aspects during the creation process for a user interface is important for a designer. Here, a closer look at specific software tools could be taken.
6.7 Speculations for the future

Actual statistics show the increase within the mobile sector. But also in the sector of 3D user interfaces, there will be more development. Especially for computer games or simulations, a new kind of user interface is needed. Thus, new challenges for developers of user interfaces appear. Also the aging of the population is an important factor for the future. Especially for older generations, who haven’t grown up with Facebook or other new media platforms, a better sensitivity is necessary regarding to the creation of user interface. Here, new markets, especially for the needs of older generations, can be created.
References

Goth, G., 2011. IBM PC retrospective: there was enough right to make it work. Computer, 44, p.26.


Appendix

Note: Since the conversation was done by e-mail, only the questions are listened here. The questions were sent separately by e-mail, next to normal e-mail conversation.

Original interview questions

How do you start a design process for a new user interface?

Do you use any specific technique to forecast the possible steps of a user? If yes, which one?

Do you evaluate a user interface in a special way? If yes, which way?

What for ways do you use to give the user a feedback of a performed action?

How do you reach a very easy usability of the UI for the user?

If you use colors, will you look at the attitudes of the colors or do you have a preferred color collection you use for the design of a user interface?

Do you respect special rules for the design of a user interface? If yes, which one?

Do you use official design standards for the design of a user interface? If yes, which one?

If you design a user interface for a Tablet and a Smartphone: What special differences have to be respected?

What ways do you use to get a “user perspective”?

What are common important design aspects for you?
University of Borås is a modern university in the city center. We give courses in business administration and informatics, library and information science, fashion and textiles, behavioral sciences and teacher education, engineering and health sciences.

In the School of Business and IT (HIT), we have focused on the students' future needs. Therefore we have created programs in which employability is a key word. Subject integration and contextualization are other important concepts. The department has a closeness, both between students and teachers as well as between industry and education.

Our courses in business administration give students the opportunity to learn more about different businesses and governments and how governance and organization of these activities take place. They may also learn about society development and organizations' adaptation to the outside world. They have the opportunity to improve their ability to analyze, develop and control activities, whether they want to engage in auditing, management or marketing.

Among our IT courses, there's always something for those who want to design the future of IT-based communications, analyze the needs and demands on organizations' information to design their content structures, integrating IT and business development, developing their ability to analyze and design business processes or focus on programming and development of good use of IT in enterprises and organizations.

The research in the school is well recognized and oriented towards professionalism as well as design and development. The overall research profile is Business-IT-Services which combine knowledge and skills in informatics as well as in business administration. The research is profession-oriented, which is reflected in the research, in many cases conducted on action research-based grounds, with businesses and government organizations at local, national and international arenas. The research design and professional orientation is manifested also in InnovationLab, which is the department's and university's unit for research-supporting system development.