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Design versus design – From the shaping of products to the creation of user experiences.

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Abstract

The concept of design in the context of Human-Computer Interaction is discussed based on definitions from industrial design to the very practical problem of achieving usability in industrial projects in practice. Design is an important quality of a product that today has not been receiving enough attention when it comes to computerised artefacts. But design is also a process of creating the user's experience of a system and this paper focuses more on design as a creative process of communication than on a posteriori product quality aspects. The Scandinavian tradition has herein been very influential in stressing the importance of the users participating actively in a user-centred design process. The paper defines and discusses user-centred design in the light of the theories of communication as put by Herbert Clark. Communication is identified as one of the key issues that need to be addressed in order to achieve well functioning user-centred design. The paper discusses different terminology and gives examples from a theory on common ground. Finally, mock-ups, prototypes and video are discussed as tools for facilitating communication and construction of common ground.

Introduction

This paper discusses the concept of design in the context of Human-Computer Interaction (HCI). HCI is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them [ACM, 1992]. HCI involves a set of processes, dialogues and actions employed by a user[1] to interact with a computer to perform a specific task [Baecker, Grudin, Buxton & Greenberg, 1994]. Hence, HCI deals with everything that in one way or the other can affect or influence the actual use of an IT-system. But, in addition to the quality design brings to the computer artefact it also involves the processes by which we study, develop and create the design of such IT-systems. In all processes for designing user interfaces the "user" takes an active role, often regarded as one of the experts necessary to co-operate with.

Even though user-centred design has received wide attention over the last years, there are numbers of reports disseminating various problems in bringing genuine user-centred design to the system development process. So why are user-centred methods difficult to realise in practice? When reading theories about how to work user-centred, such as Greenbaum & Kyng [1991], Beyer & Holzblatt [1998], Gould, Boies & Ukelson [1997], everything seems to be manageable – there are even standards [ISO, 1998; ISO 1999] to guide us. So what is then the problem? Numbers of discussions with groups composed of academic researchers and practitioners within the field of HCI have been performed [Gulliksen, Lantz & Boivie, 1998; Gulliksen, Lantz & Boivie, 1999]. These workshops have facilitated a discussion between academic researchers and practitioners exchanging experiences. An extensive list of experienced problems includes topics, such as, organisation, development process, competence, roles, and communication. One topic that is always brought up as a major

[1] When we use the concept of "users" in this paper we refer to the (actual) end-users of a system and not the (democratically elected) user representatives that has been the main focus of the Scandinavian systems development tradition.

problem is *communication*. Issues such as: Who should be responsible for talking with the users? When, where and how?

This paper will take a communication theory perspective, describing well-known practical problems in user-centred design and particularly in relation to communication aspects. Combining user-centred design and communication theory suggests a new way to solve the practical problems managing the communication as a common ground. This paper will not report on empirical findings from user studies but rather theoretically discuss state of the art and the theoretical implications this has on the interpretation and use of a user centred development view.

Nordic traditions and focus

Experimentally oriented researchers state that results that have not been obtained in the laboratory are of no scientific value and therefore useless. With the speed that the science of HCI develops, however, it is both unwise and impossible to subject every observation to laboratory study. Therefore, laboratory studies can serve as an important input to the development process, but, only as a complement to the study of real users in a context. It is important to go out in the field and study how people actually work, individually and in teams, and especially the ”fine-grained details of the information used in the real world” [Neisser, 1976].

The Nordic tradition recognises the extensive “use” of the users in the process of designing IT-systems. Involving end-users as first class participants together with developers and managers in projects where new technology is introduced is a well-established principle in Scandinavia [Nygaard, 1986]. The concept of User Centred System Design, as Norman & Draper [1986] first used it, emphasises the study of the user in the production of human-computer interfaces, but without necessarily involving them in the process. Their theories on the mental model of the users and the designers in using and designing a system and the difficulty in capturing the nature of the mental model was an important step in the argumentation for an active involvement of the users in the design and development process.

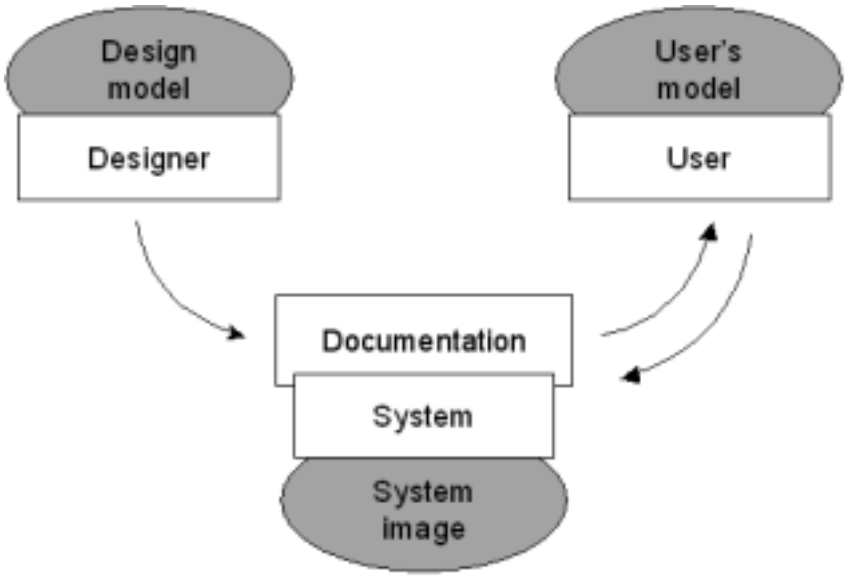

Figure 1. The System Image, the resulting abstraction of the designer’s conceptual model, is what the user interacts with to establish a user’s mental model of the system. (From Norman, D.A., 1986, Cognitive Engineering, In User Centered System Design, Norman & Draper (eds.) Lawrence Erlbaum Associates.)

Norman [1986] identifies the Design Model – that is, the conceptual model of an information system held by the designer, the User’s Model – that is, the conceptual model formed by the user and the

System Image – the interface image resulting from the physical structure that has been built (including documentation and instructions). The System Image is the physical image of the computerised work situation. By perceiving this, the user's mental model can be derived. The design problem is to create a system that follows a consistent, coherent conceptualisation (the design model) so that the user can develop a mental model (user model) of that system consistent with the design model. Note that the User's Model is not formed from the design model but from the way the user interprets the System Image. It should be realised that everything the user interacts with helps to form that image.

From the description it is easy to think that the designer has the correct model of the system. This do not have to be the case since also the designer like the user can misinterpret how a system work or lack knowledge about parts of the system. A complete and correct model of a system might not exist within one individual but among many.

Norman's view is important in that it explains the difficulties creating the mental model of a user interacting with a system, but in terms of identifying hands-on information about methods and processes to perform user-centred design it was quite premature. Today most developing organisations claim to do user-centred design and development, but the procedures and end-results can vary significantly.

The lacking focus on the users and their tasks in traditional systems development methodologies has over the last decades found itself challenged by the growth of user-centred methodologies and processes. What is commonly known as the Scandinavian approach to systems development stresses the importance of the user participating on equal terms as the developers [Greenbaum & Kyng, 1991]. The American terminology used for the approach is what is known as participatory design [e.g. Schuler & Namioka, 1993; Müller, Haslwanter & Dayton, 1997] which even further has developed to stress the importance of the democratic aspects of the user, that is emphasising the rights of the user to participate in the design of interactive systems through e.g. the trade unions or gender issues. The Scandinavian approach as we know it is more explained using the concept co-operative design [Bjerknes, Ehn & Kyng, 1987; Ehn, 1988] which grew out of an emphasis of the co-operation with the end-user's organisations (e.g. union organisations) to amplify the legal and democratic right of the users to influence and control the work situation of the future. The general assumption is that the users should be not only involved, but in control of the analysis and design process. The active co-operation with the user in the design process is today recognised as common and essential in the Scandinavian countries today.

The effect of end-user co-operation in system design is also proven through the CHAOS-report. The CHAOS Report [Standish Group, 1995] showed that out of 8,380 investigated projects in the United States, only 16.2 percent were completed successfully—that is, on time and on budget, with all features and functions as initially specified. There is no reason whatsoever to believe that this should be different now, six years later, or that the conditions should be different in other areas, such as Europe. For the successfully completed projects, the major success factor was active user involvement in the development process [Standish Group, 1995].

Regardless of the approach, Nordic perspectives imply that users are of an undisputed importance in the user interface analysis, design and evaluation phase. Even if this is more or less taken for granted in practice today, there are numerous examples on situations in which the involvement of the users is suppressed. The reasons for this may be lacking time, communication problems, organisational problems, bad attitudes, lacking competence or simply focusing the attention on the project to keep up with times and budgets. Nordic research is therefore oriented towards new ways of marketing and/or forcing user-centred design in organisations. Introducing usability champions or user-centred design facilitators in the development process can do this [Göransson, 2001]. It can be done by extensive competence development of all parties involved in the development work, from users, to software developers to project management. It can be done by introducing standards, procurement or legal jurisdictions or by promoting a user movement, such as the initiatives by the Swedish union organisations in their attempts to create a user movement towards increased usability and accessibility in working life [UserAward, 2001].It can be done through the introduction of different quality measures in the development work.

But, the major problem with all of these different approaches is the focus on the product, and perhaps, in relation to the users of the product. Some attempts have been made to put the emphasis on the process, that is providing means to certify the use of a process that takes the users actively into the development work. These attempts are important as they recognise the difficulty in expressing the user needs in advance, as the users develop their views on their needs as the development moves forward. To continue the discussion around different approaches and continue to develop new methods and processes is important as the discussion in itself promotes user-centred design and increases the users demand for improved usability.

There is, however a risk if it is only the user's say that counts in the development work. Even if we recognise the importance of the user's active participation to share their extensive knowledge of their work task, and as representatives of the typical users, we know that the users may not always know what is best for them. The users are not always aware of their work behaviour, nor are they experts in design and HCI. A user-centred design facilitator can therefore help by having the responsibility of interpreting the users requirements to track down what the users really want and need. The facilitator must help the users to understand the potential of new technology and help them develop their work procedures alongside the development of new IT-support for their task

Design versus design

Design is a difficult concept used in many different ways. Industrial and graphical designers use the word design in a different way than e.g. software engineers, system developers and behavioural scientists. The concept of design has its origin in the art disciplines and it can be defined as:

"a creative activity that involves bringing into being something new and useful that has not existed previously" [Jones, 1981].

Within industrial design, design is often referred to as the physical shaping of a product, based on theories of product semiotics and the results of a function analysis. Industrial design can be defined as:

"the arrangement of formal elements to a whole, considering technical, ergonomic, economical, social, aesthetic and other factors, mainly in mass-produced products (but also environments or services) with a specific function given in advance" [Monö, 1974].

Even though industrial designers have a long tradition of user involvement, the notion of the user is embarrassingly absent in such a definition, and in fact, recent definitions, as described by Krippendorff, rather stress that:

"design concerns itself with the meanings artefacts can acquire by their users" [Krippendorff, 1995].

In the HCI literature design is referred to as an engineering discipline and by doing that the development process is immediately put in focus:

"Engineering design is the use of scientific principles, technical information and imagination in the definition of a mechanical structure, machine or system to perform pre-specified functions with maximum economy and efficiency. Design refers to both the process of developing a product, artefact or system and to the various representations (simulations or models) of the product that are produced during the design process" [Preece, Rogers, Sharp, Benyon, Holland & Carey, 1994].

The purpose of the design could, if you look at the extreme poles, either be a way for the artist to express him-/herself or to create the maximum benefit for someone else. An artist may not have the viewer in mind when painting a great piece of art, while the industrial designer may have the aim to

create an artefact for somebody to use, by developing and adapting the artefact in a procedure involving iterative testing of a mock-up of the artefact. The truth is, as always, somewhere in between. Good design defuses the tension between functional and aesthetic goals precisely because it works within the boundaries defined by the functional requirements of the communication problem. Unlike the fine arts, which exist for their own sake, design must always solve a particular real-world problem [Mullet & Sano, 1995) Or, as Donald Norman so elegantly puts it in his book ”The Psychology of Everyday Things”:

“An ordinary user can have problems using a swing door, turn on an automatic faucet or programming his/her VCR. In most situations the designer aimed for beauty, not utility...He probably won a design prize” [Norman, 1988].

No matter what, the introduction of a designer or design expertise in systems development is of utmost importance to arrive at a successful result. A well-functioning and appetizing design does almost never occur without the work of a skilled craftsman.

The multidisciplinary character of user-centred design is also stressed in the international standard ISO 13407 Human-centred design process for interactive systems [ISO, 1999]. In addition to the design, knowledge of the human being is also essential. For behavioural scientists, the role within systems development and design of artefacts is most similar to the role of the industrial designer, and in addition it involves empirical testing of the designed artefact, and not so much process of actually constructing the mock-up or prototype. A person with a background in behavioural science is often given (or takes) the role of a facilitator, a mediator, aiming at bridging the gap (that unfortunately still often exists) between the designer and the user. Mostly important to recognise is the effect of mutual learning that comes with cooperative design and work [Bratteteig, Bjerknes et. al., 1991].

Several development processes also stress the importance of incorporating a *“Usability champion”* in the user interface design, and that this is a role more like the HCI expert focusing on usability throughout the development process, keeping it user-centred. Therefore, design is a very complex process involving various roles with overlapping responsibilities. The process is complex both because of these unclear responsibilities and because of the ill-defined problem of creating a design. J. C. Jones has expressed the problem of design in the following way:

“Is designing an art, a science or a form of mathematics? The main point of difference is that of timing. Artists and Scientists operate on the physical world as it exists at present, Mathematicians operate on abstract relationships that are independent of historical time. Designers are bound to treat as real that which exists only in an imagined future and specify ways in which the foreseen thing can be made to exist” [Jones, 1981].

Despite these various definitions of design the term is often misused for the entire software development process, thus in practice putting the design into the hands of the software engineers. This is neither good nor appropriate in that only a smaller subset of the decisions that are made during the software development process are directly related to the design. As a complement, we argue for a thorough understanding of the users and their tasks and experiences. This should result in a maximisation of the satisfaction and entertainment of using the resulting artefact.

The design is just one part - but an important one.

Design as Communication and Common Ground

In order to reach a common ground we need common knowledge (knowledge that everybody in a community have) in a domain [Clark, 1996]. When two persons act in a situation towards a person they act on their believes and on what they understand as their common ground. Aspects influencing the common ground are for instance nationality, profession, ethnicity and gender. For each of these, there are people who are members (e.g. Swedes belong to the group Swedish people and have some things in common such as customs, language and skills about the Swedish society). Members of the group (insiders) know for instance about the custom midsummer, non-members (outsiders) of the

group might not. For instance a work team at one specific work site know all the rules for this group. The insiders, that have specific information about the group and its members, expect other members to have that specific information too. An outsider might think the rules of the group are well known but they may not be, at least not in the same manner as the insiders do. The description of an insider can be transferred to an expert of that specific community, even though sometimes with difficulty. Every kind of expertise of facts, believes, procedures, norms and beliefs that members in the group expect that they can take for granted exists. Everybody belongs to several different groups and can identify people by the group they belong to and the cultural group they come from. Different groups also use concepts in different ways or with different meaning. For most activities, the common ground at any moment, can according to Clark [1996] be divided into three parts:

- Initial common ground - Background information, suppositions and believes that participants are supposed to have when they start a joint activity.
- Current state of the joint activity - What the participants know about the coming status of the activity that is going to be performed.
- Public event so far - Events the participants knows that occurred before the event take place.

Albeit a common ground there is some difference between the participants in a joint activity and this difference can be undetected. What the participants regard as a common ground in a joint activity fall within three frames: what they know before they start the activity, the temporal status of the activity, and public events that leads to the momentary status. This description is very usable for the early stages of building a common ground such as in the initial stages of a user-centered design.

In order to build such a common ground designers and HCI professionals need to have close contact with the users. The Scandinavian tradition [Greenbaum & Kyng, 1991] argues for contact over time, in which all participants can learn from one another. This is indeed an approach to recommend but, it is sometimes necessary to make modifications to the methodology. This must be done in order to make it work in practice, i.e. we do not always have the time or money it takes to work in a co-operative fashion or with real ethnographic methods. Below we suggest how we can build a common ground by using artifacts as mediators for learning.

Communication Problems

The lack of ability, time or interest in trying to understand and interpret the worlds of the various roles involved in the development work, indicate a problem of communication. Is it the group process, the way in which the participants co-operate, or actually the awareness of the importance of understanding each other that is insufficient? We asked our peer-researchers, in our workshop discussion on “user-centred design, problems and possibilities” [Gulliksen, Lantz & Boivie, 1998], to write down advice related to communication and the following three aspects were considered the most important:

- Meet the users.
- Learn more about human communication in daily life.
- Support construction of shared understanding.

Communication is essential to the success of a systems development process. The development domain influences the way in which the gap between users and developers are bridged [Grudin, 1991]. People of varying backgrounds and skills have to work together, each contributing their expertise in domains fairly unknown to the other participants in the process. One major aspect is therefore supporting communication between the different participants in the project. The questions are: Who should talk to whom? and, Where should the participants of the project meet? Should the system developers and the users have direct communication or should a facilitator act as a “go-between”.

What are the responsibilities and tasks of a facilitator? A facilitator needs to know about business targets and organisational goals and how to communicate with the users and communicate results from the field to the developers. In short, the facilitator must understand and communicate the context of use as well as the context of development. The workshop discussions resulted in the following advice:

- Facilitators must get a better understanding of how designers work.
- Designers must always directly meet the users.

We need tools or methods to help people see things in the same light. We also need to improve existing theories on how people communicate and provide tools that facilitate communication in the field among the different groups of people that are involved. Thus, we, as researchers, must work in the field to create examples that make the communication more visible and more concrete.

Mutual shared understandings

Meetings among the involved individuals support the construction of a shared understanding of, for instance, the context of use and the current possibilities and limitations of technology. Such meetings might also lead to a shared understanding of different concepts supplied by the different groups of people involved.

Should the users have to learn to understand the designers? Not necessarily, but the designers must understand the user and show what the technology can be used for. It is in some cases important for the users to understand the design constraints and possibilities and the designers should be responsible for mediating this knowledge. Mainly user-centred design is in this way about helping users express their needs, ideas and expectations.

Language can be one way of maintaining power. Each time we enter a new work site to start working with a new user group we have to build a common ground for communication, a co-construction of a shared understanding [Karasti, 1998]. This must be done every time you start a group process. This will provide the basic knowledge about, e.g., the work site, the work performed, and it promotes a common agreement on the language and concepts used and their meaning.

Users must understand that the design is a complex process involving trade-offs. This may empower the users. Users cannot express their needs because of the complexity of the technology. Therefore it is our role to explain the technology to help users generate ideas about what they can use it for. Shared understandings can be initiated through confrontation and personal values or it can require consensus and shared values. Basically, shared understandings are based on individual level; - on attitudes, social skills, what I am supposed to do, and what I can expect from others.

Different Terminology

The terminology used in development work is very important for the outcome of the interaction with the user. Users do seldom communicate efficiently with other means than their corporate language. Despite this, when expressing their needs users can tend to inadvertedly use computer technology, for example “We need the following icons and buttons”. This tendency is common regardless of the user's previous computer experience. Users do not work with scroll bars, radio buttons and Windows, even though these elements can be used, if appropriate, for another specific work task. Operating the commuter is never meant to be the task in focus, rather a tool for achieving the work task. Our experience is that if the users can express their work in a work-related terminology, they can easily communicate in terms relating to their own work activity. They may though get confused or feel intimidated if asked to use computer terms or design terms. To understand and clarify the different terminology and be able to start to use the same concepts, the use of something concrete, such as mock-ups, prototypes and video can help, both initially and also throughout the process.

Competence

Existing theories of user-centred design makes this process sound very simple, but the complexity of achieving the common ground is often underestimated, it requires specific competence. Relevant

theories, standards or checklists of various kind gives you lots of good advice but they are often not detailed enough to tell you how to work in a user-centred fashion. Competence is needed, but what is competence and how can it be gained? To be able to understand this we need to discuss the concept of competence to get a thorough understanding of the ways in which the required competence can be introduced.

Adler and Frössevi [1996] describe that competence earlier was regarded as formal qualification, e.g., enough knowledge for a specific work position. The word competence comes from the Latin word "compertere" and means to fit in or to be suited for. Now the term has a broader meaning. On an individual level competence can be divided into: *professional competence*, that is directly connected to work tasks, *social competence*, that is a persons ability to co-operate with others, and finally *learning competence*, that is the ability to learn new things. Competence can also be regarded as the ability to solve and meet tasks and external demands on a goal oriented way in relation to the actual situation [Dilschman, 1992 in Dockerty, 1993].

According to Dockerty [1993] knowledge is one component of competence. There are different kinds of knowledge:

- *Declarative knowledge* or *propositional knowledge* (knowledge that can be expressed in rules, universal theses or laws). Dockerty says that this is the knowledge of sciences and theories.
- *Procedural knowledge* or practical knowledge (skill, acquired by practical exploration).
- *Tacit knowledge* (acquired by analysing typical examples of performing a task). This knowledge is according to Dockerty, proven by the ability to perform and act with a sound judgement in different situations. The knowledge that can be seen in actions but not articulated is called “silent knowledge”.

Several education programs and informal training programs have specified the competence requirements on the participants in such a group activity, but this is not enough. The knowledge needed to work in a user centred fashion is not easy to communicate since it to a large extent is knowledge of a tacit nature. However, by providing the right environment to enable for a group of people to share their understandings, this can be facilitated To enable a person to learn at work she needs a *context*, a *goal*, a *plan*, *feedback*, *reflection* and *social context* [Dockerty, 1993]. This will support the communication in the group. The context needs to offer variation, rotation, and change. The goal for the activity and a model for its prerequisites for planed activities, gives the user the possibility to act rationally, think first and then react as a consequence of the thought. The plan describes which activities to perform to meet the goal. The user needs feedback on the activities, that is, did the action bring us closer to the goal? Without feedback the motivation for carrying out the work will decrease. After planning, action and feedback we need to reflect upon the experience. The finally, by providing a social context, the process of reflection can often be supported by colleagues in a group. These group processes leads also to a collective knowledge in which the workers share a common model of the activity.

The optimal way to build a common ground and to learn from each other is to have a frequent contact over time and maintain an ongoing dialog. We know that this opportunity only works for a few and that other alternatives are needed. Alternatively, using a master - apprentice relation can enable learning about knowledge that has a procedural or silent character.

Having something concrete to talk about e.g. mock-ups and prototypes in different designs and at different stages of completeness. Using video-recorded material from the field can facilitate, for instance, for designers to learn more about a specific user group's actual work and work context.

Video, mock-ups and prototypes as tools to facilitate communication

Masoodian [1999] argues that videos can be used to improve the effectiveness of group communication in user-centered design. In contexts outside the organizational settings, the effectiveness of tools such as open-ended interviews and questionnaires is reduced. Instead, videos can be used. In a particular project, a video illustrating a use scenario was shown to potential users in

a workshop. Their response was positive – they claimed that seeing the video helped them visualize the possibilities offered by the application. It also assisted the users in contributing new ideas to the design team.

Video is a very useful medium for analysis and for visualising current and future scenarios. Video is also a very efficient medium for showing developers how users actually use the products that they have designed. When a developer has seen a user perform the same error a couple of times there is no need for further convincing that the design must be changed, compared to a error report written on a document. In order to facilitate fruitful and informative interviews and to learn about the hierarchies of the workplace in advance, spending time at the workplace with a video camera is very useful. Video can be used for showing designers what is happening on the field with the developed systems or during the performance of work tasks, a shortcut to real observations on the field [Buur, Binder, Karasti & Brandt, 2000]. Finally, video can also easily be used to represent and visualize a future scenario or a prototype of a future system in its imagined environment.

Prototypes are a means for facilitating the construction of a shared understanding. The primary purpose of a prototype is to enable communication, in that it provides concrete features to discuss, rather than providing the one and only answer to the problem.

You could however help the users think in design terms that are related to their reality by using low-fidelity mock-ups. The positive aspects of using mock-ups is according to Ehn and Kyng (1991) that they encourage hands-on experience, are understandable, are cheap and fun to work with. That the functionality is missing is viewed as an advantage since this will allow the user to interact with the mock-up in a natural way and without any limitations. By leaving the prototype on a low-fidelity level, the comments that the users supply become much more extensive and useful for the developers. This has been proven in an experiment in which a comparison was made of the user comments on an interactive prototype and a rough drawn sketch of the same prototype [Belotti & Smith, 2000].

Representations[2] are context-dependent links between groups, abstractions with multiple faces. They can be used as platforms for creating a shared understanding of, for instance, a design solution or user requirements. Representations used in systems development must bridge the gap between the users and the developers, as well as the gap between the facilitator and the developer. However representations solely does not facilitate the communication in all cases. Mørch [1998] has described tools to be integrated into already built systems to facilitate tailoring to the user's specific needs in each situation. This is another way to recognise the iterative nature of user centred design that you cannot do right at once.

Discussion

The multidisciplinary nature of true user-centered design is described in this paper, and especially the influence of the field of design and HCI, on the development processes. Even though user-centered methods have become widely applied, the problems in using them in practice are constantly reported. Particularly focusing on communication issues in creating a common ground for user-centered design the following suggestions are discussed in the paper:

- The user-centered design facilitator, an important role in the system development process, has the responsibility to intermediate between the users and the designers. The person that holds this role often has to resolve conflicts and represents the users in the eyes of the designers and vice versa. A skilled facilitator should have knowledge in building a common ground among different actors in the design process. Some also think that a multidisciplinary background (to how humans interact with computers and other human beings, how computers and software works and the context of use) is necessary. However, systems developers and designers must meet the users, without "go-betweens" – everyone involved in the project should see the system or product in real use.

[2] The concept of representations is in this paper used to refer to (external) artifacts (mock-ups, etc.), not to be confused with internal (mental) representations,

- Communication problems occur when people with varied skills and expertise communicate with one another. Therefore, respect for other people's expertise and skills is essential for bridging the communication gap. Although user centered design is about helping the users express their needs, it is also important to acknowledge the need for users to understand the possibilities and constraints of the technology and the complexity of the design process.

- Effective representations are essential for the success – representations facilitate communication and the building of a shared understanding. With representations we can communicate the results of such activities to the people within the project as well as to people outside the project. Mock-ups, prototypes and video are important tools for representations (video can also be used in the analysis, design and evaluation process). Low-level prototypes are cheap and efficient means for having users generate new ideas about how to use new technology. It is however important to ask appropriate questions when the prototypes are evaluated. Prototypes can also be used for creating a shared understanding of the context in which the new system will be used. Video is useful for capturing important aspects of the work context, such as pre-information about power structures, routine manoeuvres and pieces of tacit knowledge, that otherwise may remain uncovered.

Communication skills are critical for the success of the project. The main purpose of the process is to support successful communication. But communication is not just about getting knowledge from one person's head to another, but about the creation of new group knowledge, not necessarily grasped in totality by any single member [Dix, Finlay, Abowd & Beale, 1998]. Mock-ups, prototypes and video can assist in visualising the "black holes" due to misinterpretation or a lack of understanding.

Commercial development processes do seldom support methods for creating a common ground, why this must be pursued in the future. Even though we strongly recommend designers to meet the users on the field we know that this is not yet the reality in design projects. Attitudes are essential for the success of communication. No matter what tools and methods we use, if people are not willing to listen or to share their experiences and skills with others, the project will fail. Attitudes can be changed in a learning process - by thinking in different ways much can be gained. System developers do not see their work role as service in a work context. Many system developers regard computer system development as an artistic occupation with an expressive task, or a task of breaking new technical limitations. These attitudes have to be changed.

The participants in the design process seldom have the knowledge, competence, special abilities or even interest in working in a user-centred fashion. HCI knowledge is, despite decades of research, still relatively unknown to most participants in practical systems development. In distributing this knowledge our universities and teaching institutions have a responsibility. A great deal of research has been performed in this area, especially in Scandinavia, but these results seem to be difficult to apply. Researchers have to make the research results available and accessible as methods, tools and knowledge and to disseminate this knowledge on the market. We have to work with parallel activities in order to increase the general competence in this field. The universities have a great responsibility in educating more people in HCI and in communication and creating common ground in the user-centred development process. This is though a slow process and should be performed as a parallel activity to the above presented solutions with apprentice ship and working with concrete examples of design at different stages of completeness such as mock-ups, prototypes and video recordings.

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