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Persons with functional difficulties as resources in ICT design processes

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Abstract

This thesis has its roots in my experiences of working with people who have some forms of disability. Usually this group is the last group producers consider as their customers. It is quite common that producers make different products (and services) for individuals with disabilities and for others. If one instead takes the position, in the design work, that most people have some functional difficulties at some point in time or in place, then the potential customer group becomes larger for the product in question.

The origin of this thesis is a project run by the Swedish Post and Telecom Agency (PTS), aiming to identify what kind of support or adaptation people with intellectual disabilities needs when using broadband based services. The result of the project pointed out areas of difficulties. Most areas of difficulties were not unique for this group.

From the result of the PTS-project, a design and evaluation model (TED-model) was built, where one of the steps involved the use of an "indicator group". The aim for this step is to identify and give basis for prioritizing areas of difficulty that the continued design work should focus on. The indicator group consists of individuals with functional difficulties relevant in a specified context. This method uses the possibilities of "design for all" as facilitator to design better products for more people.

The empirical studies in this thesis were carried out within two areas. The first study was made in a design project, where five different web

sites were to be designed, and the second one dealt with three different business workplaces in which the cashier workplaces was in focus.

The results of this thesis point out a possible direction of a design methodology, whose objective is to create better products for larger group of people. The starting point is to use people's differences as a possibility for design, and not a problem.

Individuals with functional difficulties constitute a resource for finding new innovations, which I have termed “the Lead of Need”. With this I mean individuals with functional difficulties, who have a need, an idea for a solution, but not the possibility to make it happen. If we can organise a meeting ground for individuals with “the Lead of Need”, designers, and developers, we will have created a “living lab” for new innovations.

Keywords: “Design for all”, functional difficulties, usability, useworthiness, accessibility, design methodology

Sammanfattning

Denna avhandling har sin grund i mina erfarenheter av att arbete med människor som har funktionsnedsättningar. Vanligtvis är denna grupp den sista en producent ser som sina kunder. Det är ganska vanligt att producenter gör olika produkter(produkter och tjänster) för personer med funktionsnedsättningar och en för andra. Om man istället, i designarbetet utgår från synsättet att de flesta personer vid någon tidpunkt och/eller plats har funktionssvårigheter så blir den potentiella kundgruppen större för produkten.

Ursprunget för avhandlingen är ett projekt, vilket drevs av PTS (Post och Telestyrelsen), med syfte att identifiera vilka typer av stöd eller anpassningar personer med intellektuella funktionsnedsättningar har för att använda bredbandsbaserade tjänster. Resultatet i projektet pekade ut ett antal svårighetsområden där flertalet av dessa svårighetsområden inte var unika för denna grupp.

Utifrån resultat i ovanstående projekt togs det fram en test-, utvärderings- och designmodell (TED-modellen) där ett av stegen använde en ”indikatorgrupp”. Syftet med modellen är att identifiera och ge underlag för att prioritera vilka svårighetsområden det fortsatta designarbetet skall fokuseras på. Indikatorgruppen består av individer med funktionssvårigheter som är relevanta i sammanhanget. Modellen tar vara på möjligheterna i ”design för alla” för att göra att göra bättre produkter för människorna.

De empiriska studierna i denna uppsats är gjorda inom två områden. Den första är i ett designsammanhang, där fem olika hemsidor skulle tas

fram och den andra är runt en studie av tre olika affärsarbetsplatser, där kassafunktionen var i fokus för studien.

Resultatet i denna uppsats pekar ut en möjlig inriktning för en designmetodologi, vars målsättning är att få fram bättre produkter för en större grupp. Utgångspunkten är att använda människors olikheter som en möjlighet och inte som ett problem.

Individer med funktionella svårigheter är en resurs för att finna nya innovationer vilket jag har benämnt ”the Lead of Need”. Med detta menar jag att individer med funktionella svårigheter, som har ett behov, en ide för en lösning, men inte har möjlighet att förverkliga denna. Om vi kan organisera en mötesplats för individer med ”the Lead of Need”, designers och utvecklare så har vi skapat ett ”Living lab” för nya innovationer.

Nyckelord: “Design for all”, funktionssvårigheter, användbarhet, användvärdhet, tillgänglighet, designmetodik.

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Persons with functional difficulties as resources in ICT design processes

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1 Introduction

Design for all is sometimes used as a vision of not excluding anyone from using designed products or services. To do "design for all" is by some regarded as an expensive and not possible approach. Some also mean that this perspective is more expensive and time consuming than the approach of user-centred design (UCD).

"Easy to use" is often used as one of the main targets in the usability area. When designing new ICT product or services, there are a couple of ways to approach this usability area. One of the ways is to see usability as an attribute of the product or services, as in ISO 9241 (Smith, 1984) (Mayhew, 1992), and another is to see it as a design approach as for example in usability engineering (UE) (Tyldesley, 1988) or in UCD.

What kind of usability are we then discussing? Further on I will discuss how to narrow it down from "easy to use" to a more tangible property as "easy to understand" and other "easy to …" properties. Then it is possible to get a better understanding what the difficulty is and by that get more usable products and services.

The question that follows is: Who can identify these usability difficulties best, is it an ordinary user, some experts or is it possibly persons with functional difficulties? If persons with functional difficulties are better in

identifying areas of difficulties could they be one of the recourses in designing ICT-based products or services and for making them more usable? If persons with known difficulties are a resource, then in what way can they contribute?

The TED-model (Test-Evaluation-Design), which is more described in chapter 5, is a work method of doing design or evaluations with a focus on accessibility and usability. In this model an indicator group is designated to find difficult areas of the design. This is a proposal of how to develop the ISO standard of "*Human-centred design processes for interactive systems*" 13407 (ISO 13407, 1999) to a higher usability level.

The ISO 13407 standard for the Human-centred design processes for interactive systems is an iterative flow of how to handle the users' and the organisations' input and their context in the design process. This was used in the EMMUS-project (European MultiMedia Usability Services, 2002), as a facilitator for user involvement in the design process, with very good result. The result was measured as a level of usability as defined in the ISO 9241-11 (ISO 9241-11, 1998) efficiency - effectiveness and user satisfaction. The user is defined as the user intended for the system both in the ISO 13407 and the ISO 9241-11 standard.

I have experienced that users' abilities vary over time and in relation to context. A user can be involved in an accident or he/she can in certain time and space be stressed. Where are these aspects during the design process?

I have often been told, in development processes, that we cannot make everything for everyone. What about the "design for all" perspective, does it include everyone? I think it is important not to exclude anyone but have an open mind from the start of the design process.

A basic assumption is 'what is good for people with specific difficulties may also be beneficial for other people'. Users' ability changes over time and space. The "design for all" is an overarching goal rather than a specific promise in each single development process. Sometimes the demands are so specific that generic solutions are totally impossible, and accordingly not desirable, and beneficial for only an exclusive minority.

When we discuss individuals' abilities we have to do it in an understandable way so that all participants in a design process have a common interpretation of ability. The World Health organisation (WHO) has made a framework for measuring health and disability. The system is called ICF (WHO, 2007) which is a framework for both individual and population level measurement. Functional difficulty is derived trough ICF.

This ICF system is meant to be a common base for describing health related states of a human being and not as a diagnose classification. It supports the communication between healthcare personnel, researchers, technicians, politicians and others. It is a way to describe human functions in terms of difficulties and put them in a perspective of life quality.

I think that UCD is a good and profitable way of designing products and services. The involvement of real users in the process or at least listen to them is necessary. Looking at parts of the product/service that should be easy to use, the user/individual can be of help for identifying the difficult part and what part should be prioritised during the design process in order to increase usability. This is a main target of this Licentiate thesis.

1.1 Research questions:

The research questions are based on the thinking that all people have something to contribute to a design process. We all have differences in our experiences and therefore have different perspectives. Are people with difficulties a burden or resource in this point of view? The research question in this thesis is:

> *In what way are persons with defined difficulties resources in the design process of ICT based products and services?*

From this question three more precise questions are derived:

> *What impact on the design process has involvement of people with defined difficulties?*
>
> *What are the impacts on the end product or services when involving people with defined difficulties in the design process?*
>
> *What other issues will appear outside the design process as consequences of involvement of people with defined difficulties?*

The term "difficulties" is defined in ICF as limits of the individual's body structure and/or body function in a way, which makes it difficult to do activities and participate in all aspects of life both in an individual and in a societal perspective. By "body" is meant the whole body, as a combined mental and physical entity.

1.2 Overview of the thesis

In the chapter after this introduction (chapter 2) I will start to describe some existing design methods. All have some bearing on the "design for all" perspective, in my point of view. Further on in this chapter I will take you from an individual perspective to a collective perspective on human knowledge and experiences with design methodology in mind. At the end of the chapter I give an account of my own experience, which has coloured this thesis.

In chapter 3 I have collected some concepts and definitions that are needed in the rest of the thesis. It starts with the concepts and definitions on human functioning and ends with terms for attributes of product/service.

Chapter 4 has its focus on the usability issues. It goes from a technical to a more human perception point of view.

In chapter 5 I describe some of my practical experiences in this field. It starts with two projects, which have become the starting points of my thoughts of using individuals with functional difficulties as a resource for identifying difficulties. In section two I describe a model of design, where I have taken active part in the development. This methodology has been used in the next chapters' studies. The last part of this chapter is a practical example of a usability and accessibility test I have been a part in executing.

The second to last chapter (chapter 6) is about two studies that were made with a perspective of how people with difficulties can be resources in design/evaluation processes. The first one is about design

methods when developing web sites and the second one is a workplace study. In both studies were used a method where indicator groups were used to find difficult areas. The indicator groups in both studies were people with development disability.

The last chapter is the conclusions from the results and in what situations they could be used. The chapter is divided into “design process”, “product and services”, “other issues” and further research opportunities.

Finally, I pose a question to keep in mind when reading this Licentiate thesis:

> *In a design for all perspective, should we design cars for blind users?*

2 Users in design

In this part I will describe some design approaches or design thoughts. It is not intended to be a total all-encompassing overview, rather of those that I have some form of relationship to.

I have chosen to use the "design for all" approach in this Licentiate thesis. Who can contribute knowledge, aspects and/or better solutions that most people can benefit from, is hard to know in advance.

2.1 Design approaches

One of my main inspirations is the ISO 13407 (ISO 13407, 1999) "*Human-centred design processes for interactive systems*" guidelines. The diversity of users and stakeholders is a central asset of the design process and this is something that I have experienced in real life.

2.1.1 Human Centred Design (HCD)

The quality of use is on of the main targets of ISO 13407. The method incorporates a user centred design iteration model. This standard describes a multidisciplinary activity where human factors, ergonomics and technical issues are normal parts of the design process. It also describes that the outcome is meant to be enhancing effectiveness and productivity as well as better human working conditions.

The four main iterative activities in this process are;

- Understand and specify the context of use
- Specify the user and organizational requirements
- Produce design solutions
- Evaluate design solutions against requirements

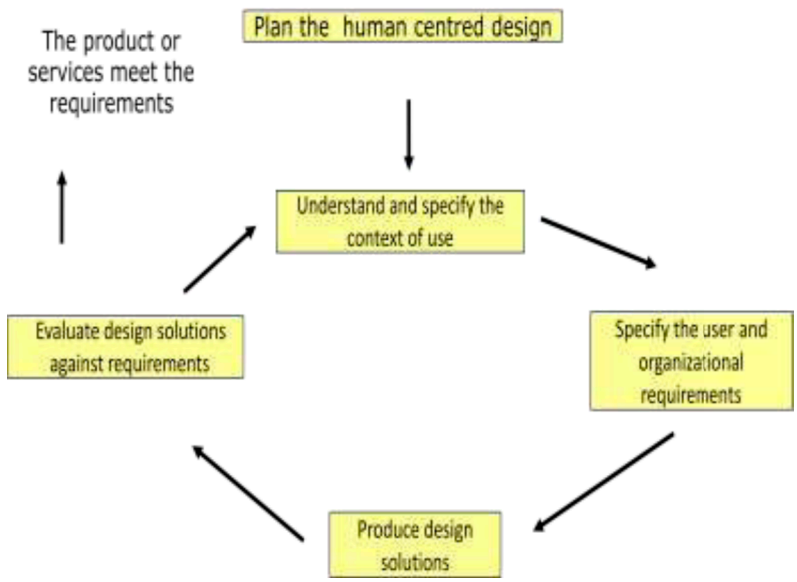

Figure 1 ISO 13 407

This is as an iterative process of design, which points out the need of knowing the context around the artefact that is going to be designed. This implicates that there is more to design than form and colour. The context of use is, in my meaning, even more about the people involved in the use environment. The model's true benefit emerges when it is used to guide an iterative development process.

An even more specified ISO standard has recently been published as "Ergonomics of human-system interaction -- Human-centred lifecycle process descriptions" (ISO TR 18529, 2004). The word "user" has been replaced with "stakeholders" in order to ensure that all persons and organisations involved are taken into account. The standard can be described in the seven steps below.

1. Ensure HCD content in system strategy
2. Plan and manage the HCD process
3. Specify the stakeholder and organizational requirements
4. Understand & specify the context of use
5. Produce design solutions
6. Evaluate designs against requirements
7. Introduce and operate the system

The iteration is made between step 3 and 6 in the same way as in ISO 13407. Both standards use the human way of deducting ideas from the former iteration.

2.1.2 User Centred Design (UCD)

UCD is focusing on the user, early and continuously during the design process. It contains empirical measurements and iterative design by multidisciplinary design teams (Gould & Lewis, 1987). Usability is a part

of the product design process instead of being separate activities made by someone outside the design team.

The user can be included in the activities but mostly the users are seen as objects that are studied in order to gain knowledge or understandings of the interaction between the human and the system.

The cost of the design process is often brought up as a holdback. The "quick and dirty" study of the object (Thomas, 1996) is one of the suggestions for a faster and less costly ethnology based method, that could be used.

Another part that could be costly is when detecting usability problems in the prototype. One solution is to hold down the amount of individuals participating in the evaluation. Nielsen suggests using as few as 8 -10 individuals in a "discount" usability test to get hold of up to 80% of the usability problems (Nielsen J. , 1994).

2.1.3 Contextual Design

Contextual design is mainly used for designing ICT-systems in existing work contexts. This methodology was mainly developed by Karen Holtzblatt. It is a structured methodology to gather, handle and interpret data from fieldwork with the intention of building an ICT product. K Holtzblatt and H Beyer point out the importance of capturing the context and its practices before doing the design for a specific workplace. In this approach the team that are doing the ICT system and the target workplace is also the customer. The steps below are a short version of their methodology.

Contextual Design in seven parts:

Contextual Inquiry: find out who the customers really are and to understand the customers on a day-to-day basis: their needs, their desires and their approach to the work.

Work Modeling: find out the work of individuals and organizations as a method of visualization, and then view the result in diagrams to provide different perspectives on how work is done.

Consolidation: to let the team see common pattern and structures from the individual interviews with the customers without losing individual variation

Work redesign: discussions of how to make the work praxis better by introducing technology for a new improved work practice

The User Environment Design: making a plan which shows each individual part of the system, it also shows how the users are supported in their work, which function there are in different parts, and how the user navigates through the system.

Test with customers: by using paper prototyping develop schematic representation of the systems windows, dialog boxes, buttons, and menus.

Putting it into practice: by prioritization the transition of implementation it is easier to plan the system implementation over time. Object-oriented design is recommended to make it easier go from systems design to design of the implementation.

(Beyer & Holtzblatt, 1998)

In this methodology, which is an ethnographical approach, the users are mainly one of the objects that the team are studying. It is the team who

comes with the improvements and then they test them with the users. The innovation possibilities are mostly brought in with the team and not with the users.

2.1.4 Universal design

This design term was coined by Ronald L. Mace. He was an architect, product designer, and educator, who have influenced a whole world. He stated the term "Universal design" as a concept of designing products and environments for the needs of people, regardless of their age, ability, or status in life (Mace, Hardie, & Place, 1996).

The universal design has its roots in the "barrier free" and "accessible" design. Mace writes that what can be barrier free for someone can be a barrier for someone else. Even specialists have problems with the design issue because of its complexity. Just to remove the barrier is not enough, the designer must think bigger.

The Universals design definition is;

> " The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design."
> *(Connell, et al., 1997)*

There are seven principles for “universal design”;

Equitable Use
The design is useful and marketable to people with diverse abilities.

Flexibility in Use
The design accommodates a wide range of individual preferences and abilities.

Simple and Intuitive Use
Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.

Perceptible Information
The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.

Tolerance for Error
The design minimizes hazards and the adverse consequences of accidental or unintended actions.

Low Physical Effort
The design can be used efficiently and comfortably and with a minimum of fatigue.

Size and Space for Approach and Use
Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

(Connell, et al., 1997)

The universal design approach is – designing all products, buildings and interiors to be usable by all people to the greatest extent possible (Mace, Hardie, & Place, 1996).

Toyota has a concept of universal design, where the cars are ready for adapting from start. If the buyer would like to do some changes in the driving environment such as changing the accelerator from using with the foot to the hand a standard gizmo can be bought and is simple to put in. They have made most of the controllers in the car replaceable. This means that if you want to change the steering it is simple to exchange the steering wheel to something else as long it is following the Toyota standard.

2.1.5 Inclusive Design

Inclusive design is almost similar as Universal Design and "Design for all" but it also includes a concept of "reasonable" in the definition. One definition of Inclusive design is the following.

> *"The design of mainstream products and/or services that are accessible to, and usable by, as many people as reasonably possible on a global basis, in a wide variety of situations and to the greatest extent possible without the need for special adaptation or specialised design".*

(Tiresias, 2007)

The name "inclusive design" also implicates that someone is excluded from the start and will be included later on. This viewpoint starts from some sort of normality and tries to bring in excluded groups.

The words “reasonably possible” express some of the main differences from other approaches. The “reasonably” is about effort, effectiveness and economics aspects of the design in this approach. This is the appealing thing for business but it is also in my point of view the danger in this approach. It is very simple to discard things as they seems to be too hard to do, cost too much and so on without building it on feeling but just on facts.

2.1.6 User Sensitive Inclusive Design and Design for Dynamic Diversity

A suggestion of a new methodology approach to UCD was made by a research group in Dundee because of their view on the nature of “Design for all” and “Inclusive design”. They mean that those are not realistic goals for all products and could even be counterproductive.

If UCD should be used, where people with disability are included in the user group, there must be changes in the methodology. The suggestion is User Sensitive Inclusive Design (USID) as an extension of UCD. Sensitive is a replacement to Centered because of the wide variety of functionality and characteristic of user groups (including users with disability, and especially communication difficulties) which makes it very hard to get a small representative sample in the user group but also to design products that are accessible for all potential users. The use of “Inclusive” points out a more realistic view on which groups can be included in the user group. (Newell & Gregor, 2000)

The Design for Dynamic Diversity is discussed in the context of designing accessible interfaces for older people, in general taking into account that as people become older their ability changes. Elderly

people are in a progress of reduction of their cognitive, physical and sensory function in an individual way. When designing for this group the designers have to take the dynamic diversity into account. (Gregor & Newell, 2001)

2.1.7 Co-operative design

Co-operative design is more than just involvement of users in the process. It is full cooperation between users and development team. They share their knowledge and experiences by designing together. In UTOPIA (Bødker, Ehn, Sjögren, & Sundblad, 2000) graphical workers participated in the process actively with their knowledge and experiences on same terms as the developer team. This approach can be described as using democracy as a facilitator "One man one voice".

In the project "KidStory" (Taxén, Druin, Fast, & Kjellin, 2001) the difficulties were how to get hold of the children's point of view in the design. It is very hard for children to get hold of adult's world of thinking and vice versa (Bødker, Ehn, Sjögren, & Sundblad, 2000) but by working around it by using practical methods where all have the opportunities to visualise their ideas it becomes more understandable for individuals from different contexts.

How the structure and organisation of the work of development is made has a large impact on the conditions of user participation. It must be on equal terms for both the users and the development team in order to get most out of the work.

In the Nordic countries there are legislations about involvement of the labour organisations in work environments. In the UTOPIA project it

was not only on organisation level the participation took place but it also involved some engaged individuals. This was probably one of the key factors of the success.

The process is also a learning process as Vygotskij (Bråten, 1998) (Kroksmak, Lev S Vygotsij, 2003) describes it, with the building of an artefact widening the group members' knowledge and experiences.

2.1.8 Value sensitive design

Value Sensitive Design (VSD) is a design method, where human values in a principled and comprehensive manner are accounted for in the whole design process.

VSD can be described with seven constellations of features (Friedman, Kahn jr, & Borning, 2002):

1. It seeks to be proactive; influence the whole design process
2. The arena in which values arises is all places which are effected of the design.
3. It enlarges the scope of human values to include all values, especially those with moral import.
4. It involves conceptual, empirical, and technical investigations
5. It is about the affect people and social systems have on technological development, and how new technologies shapes individual behavior and social systems.
6. It offers a principled approach to design that comes from moral epistemology. It doesn't matter if it is a group or an individual that upholds the values.
7. It holds values that are universal which could be cultural depending. These cultural universal values are situated and can therefore vary over time.

In point four the conceptual investigation is about how the stakeholders might be socially impacted by the design. The stakeholders can be classified in two groups: direct and indirect. In other design methods the indirect stakeholders are not taken into account.

2.1.9 Design for all

Products that are produced with the approaches “designed for all” are products that are made to be possible to use for a wide range of people. A common definition of “design for all” is.

> … This only will come as a result of designing mainstream products and services to be accessible by as broad a range of users as possible. This approach is termed "Design for All" … *(EU, 2007)*

The Swedish government has set up the goal that all of Sweden shall be accessible for all people in the year 2010 (SOU 1999/2000:79, 2000). In this goal the focus is on using the term “design for all” and this means that no one shall be excluded because of their disabilities or functional difficulties. Swedish legislation has a special law for non-discrimination in any kind situation (SOU2006:22, 2006). This law aims generally to strengthen individuals’ legal rights and at the same time give individuals that have been violated/offended a possibility to get redress and economic compensation for suffered damage.

The Swedish governmental focus on “design for all” has made the market take steps in this direction. Swedish Administrative Development Agency (Verva) has also made guidelines for procurement in the direction of usability (Statskontoret, 2005). Verva has also made a framework (VERVA, 2007) for contract procurement where principles and priorities are about usability and especially for accessibility for people with disabilities.

> "Increased attention will be given to usability, ergonomics, and accessibility for the disabled,…." *(VERVA, 2007)*

The organisation European Institute for Design and Disability (EIDD) is a European platform on "Design for All". Members in this organisation are national organisations, corporate and individual members now in sixteen European countries

> *"Across Europe, human diversity in age, culture and ability is greater than ever. We now survive illness and injury and live with disability as never before. Although today's world is a complex place, it is one of our own making, one in which we therefore have the possibility – and the responsibility – to base our designs on the principle of inclusion.*
>
> *Design for All is design for human diversity, social inclusion and equality. This holistic and innovative approach constitutes a creative and ethical challenge for all planners, designers, entrepreneurs, administrators and political leaders.*
>
> *Design for All aims to enable all people to have equal opportunities to participate in every aspect of society. To achieve this, the built environment, everyday objects, services, culture and information – in short, everything that is designed and made by people to be used by people – must be accessible, convenient for everyone in society to use and responsive to evolving human diversity.*

The practice of Design for All makes conscious use of the analysis of human needs and aspirations and requires the involvement of end users at every stage in the design process.

The European Institute for Design and Disability therefore calls on the European institutions, national, regional and local governments and professionals, businesses and social actors to take all appropriate measures to implement Design for All in their policies and actions."

(EIDD, 2004)

The design for all vision in EIDD is very close to the vision of democracy: in order to make the world a better one, we all need to be involved.

2.2 A normal person - a common user

What is a common user? A common user is often the target user of design products and services. What preference has this common user? According to Wikipedia 2006 normality was defined as:

"…an organism or mechanism that is not deviating, concerning some, several or all properties"

In the group "common user" exists 'all users'. 'All users' includes people with all possible varieties of conditions (Ohlsson, Persson, & Östlin, 2006).

Instead of dividing people in categories of functionally disabled and not functionally disabled, pensioners, immigrants, etc., where special solutions are presented for different categorized group of people, can

we design our environment in a way that gives access to a broader group of people with more or less function difficulty.

Function can change over time and can be tied to a certain situation or an occasion, which makes it problematic to have special solutions at all different possible occasions.

Considering accessibility could facilitate the life for so many more, and the risk to discriminate will decrease.

It is not so exceptional that one intends to adapt for “the functionally disabled”. This kind of thinking stems from ”we are normal" and “they are functionally disabled”. But what is then in that case of normality?

To be “normal” can have many different meanings in different contexts. It can for example mean absence of disease, that one is” common ", not deviating, not to be inconvenienced of some disability, does not have any disability, or disabilities, or may be socially competent (varies the behaviour after the situation's requirements), is sufficiently…

In certain circumstances, we are all functionally disabled more or less temporarily. A small sight reduction can lead to big difficulties if it is not corrected correctly or if a person just lost his/her glasses. It is therefore important to design products and services according to the “design for all” principles, making permissive systems that will give people the possibility to use and access them, without always demanding that the person must have the biggest possible ability.

Anyone can in certain situations and at certain occasions have function difficulties of more or less problematic nature.

To use the concept 'function difficulties' instead of disabilities can give us another view in designing products and services for all people and not always do special solution for certain kinds of groups. Special solution in itself can sometimes be considered as discrimination, while “broad” solutions, that are good for all, are experienced as natural solutions that fit the broader group. An example is a door that is opened automatically when one approaches it.

Earlier this kind of solutions was an adaptation, e.g. for people in wheel chairs. Today we do not think of those as an adaptation, when we see the in a supermarket.

Solutions of that type, promoting the equivalence and the use, can in the same way be independent of person.

Let me take an example; I intend to make a journey and I have difficulties going in stairs because of a pain in a knee. All who have travelled with train in Sweden knows that there are relatively high steps in order to go in or out of our older trains. Furthermore, I just got a message that a close relative has gotten a severe disease, and I am in a hurry to get there on time. I have no knowledge about which platform the train is leaving from and I am unsure whether my clock is showing the justice time. I am not an experienced traveller so I feel uncertain on how I will interpret the arrival and departure times in a timetable. Moreover I have got a big heavy bag with me to carry. When I, at last, arriving at the correct platform, I have problems to come on board the train, because of my paining knee and with my big luggage.

This is not directly an awkward or unlikely situation; many people can recognize themselves in similar types of situations.

In the above circumstances, with the person has functional difficulties; this is of a transient nature, but on this occasion, the combination with the environment factors became too much for him. The accessibility could have been better if there had been a permitting system instead. For example, if the train wagon had been designed better for persons to go on or off, if there had been better and simpler signs.

A normal state of the human collective is that we differ (Gregor & Newell, 2001), and humans changes over time. We can conclude by stating that there is no normal person or a representative user that we can have as a target when we are designing or redesigning products or services, if we intend to “design for all”.

2.3 Develop "Common ground" trough "Augmenting the Human Intellect"

The Greek Leonidas' famous words at Thermopylae "united we stand divided we fall" is a way to describe that we are stronger together, not only in the sense of muscular strength, but also in our collective knowledge and experience. The main thing is how do we humans know that we have the same common ground?

> *"In the experience of dialogue a common ground is created between the other and myself, my thinking and the other's make only a single fabric, my proposals and those of my interlocutor are called forth by the state of the discussion, they are part of a common operation of which neither of us is the creator."* (Merleau-Ponty, 1962)

2.3.1 Communication and learning in communities

The understanding of communication between people is a way of evolving our thinking. We say that thinking is cognitive processes that involve the awareness of attention that can be of emotional and cognitive types. Jens Allwood (Allwood, 1997) states that different kinds of communicative activities, e.g. not only talking but also using our body language, triggers our cognitive activities. This helps us to understand each other and to broaden our minds.

As early as in 1920 Vygotskij worked with children with learning disabilities and formulated that the humans are born with reflexes and psychological functions that change, develop, internalize through cultural tools (Kroksmak, 2003).

Vygotskij means that in every moment we have the opportunity to conquer or develop knowledge or experience from other human beings or we can recognise patterns and structures of our own intellectual or other practical tools that we are the masters of. By interacting with other individuals we can boost our internalizing of knowledge (Bråten, 1998) (Säljö, 2000). This internalizing is necessary for our creative activities (Vygotskij, 1995).

2.3.2 "Augmenting the Human Intellect"

In the early 60's Douglas Engelbart wrote the paper "Augmenting the Human Intellect: A conceptual framework" (Engelbart, 1962) which was a milestone. In this paper Engelbart defines "Collective IQ" as a society's or organization's "capability for coping with complex, urgent, large-scale problems". The "Collective IQ" is then the knowledge basis and experience base for the society or organization.

1967 he worked with the use of collective IQ in work environments, demonstrated in the 1968 Fall Joint Computer Conference held at the Convention Center in San Francisco. This was also the first demonstration of a new tool called "mouse" and of cooperative work over a network with audio and video interface. He demonstrates a way of visualizing the collective IQ and how to use it in everyday work in his work group.

The big problem of using the collective IQ is how to communicate it within a group.

With Engelbart's way of visualizing, the "Collective IQ" becomes something that easier could be understood and something that could be

used in work environment. He calls this strategy bootstrapping, where it was possible to create “chains of views” linked to one another. In the demonstration he showed the benefits of having a system that showed both human and system resources linked to each other in a system, as the basis of the Augment Research Center’s daily work practice. By using this online tool as an instrument for helping humans to operate within the domain of complex information structures it it is made more understandable for humans. Engelbart is talking about the connection between a service system and a user system, where he divides the overall man-computer system into a dichotomy between service system and user system. The Service system is hardware and software, which appears on the terminal, and the user system is what is beyond this.

2.3.3 The collective of union members as facilitators

The trade union has the best of the collective of workers' as their main focus. In order to get good ICT work environment for their members, the Swedish trade union LO has taken part in several research and development activities.

UTOPIA (Bødker, Ehn, Sjögren, & Sundblad, 2000) was one of the projects where a union participated. It aimed to develop the future work activities for graphical workers. This R&D project was something of a milestone for the co-operative design tradition, often called the Scandinavian IT design tradition.

In the 1990s LO members, as a collective, were given the opportunity to buy a computer that LO had made a procurement of. The aim for LO was to increase the members experience and knowledge of using computers.

LO members formed a collective realising its way of becoming a lost group in the new digitally divided society.

One of the central points was the use of computers in the work environment. In order to diminish this problem, for their members, LO formed a quality assurance project, "Quality Assurance of IT Support at Work" (ITQ) 1999-2005 together with the Centre for User Oriented IT Design at KTH in Stockholm (coordinator), Human Computer Interaction at Uppsala University, and Industrial economy at Gävle University (Walldius, Sundblad, Sandblad, Bengtsson, & Gulliksen, 2008). This project is part of the network UsersAward with the goal to develop and implement a strategy for good software on the work floor.

Users-Award's Users IT-prize contest, was one of the results of the cooperation between researchers and the union. This also led to a tool of certification of software's built-in features, its deployment process, and its actual situated usage.

2.3.4 Democratization of innovation

Von Hippel has in the book "**Democratizing Innovation"** (Hippel, 2005) described a user-centered innovation process where lead-users are those who use products a way that other users will do in a couple of years.

Definition of lead user characteristica from von Hippel;

> Lead users face needs that will be general in a marketplace – but face them months or years before the bulk of that marketplace encounters them, and

Lead users are positioned to benefit significantly by obtaining a solution to those needs

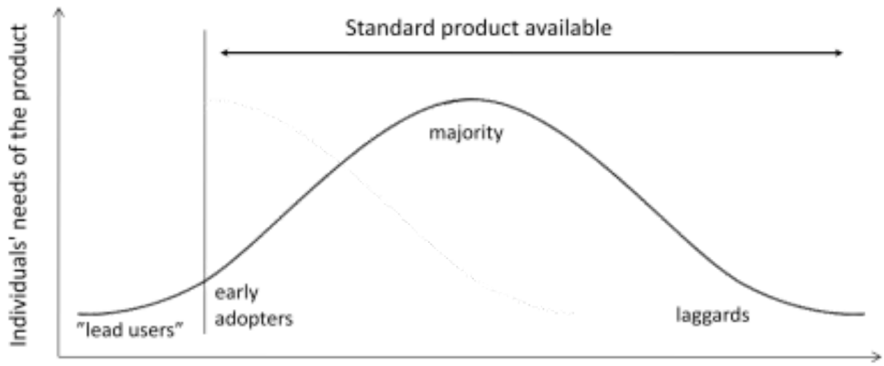

Figure 2 Lead user place in the product life cycle

An example of the lead user concept, Von Hippel describes a group of windsurfers. A group of individuals were trying to explore the limits of windsurfing. They experimented if it was possible to make jump with the wind surfboard. How much they tried it always ended that they fell off the wind surfboard. They tried different solutions but at the end they found out that a strap to put their feet in on the surfboard was the solution. The jumps with surfboards with straps made it possible to control the jump/flight on a new way. The user group developed the construction together and it became a new sport of high-performance windsurfing.

Another example is the development of the web server “Apache”. It started as needs of a simple web server and by sharing it freely others

contributed to the development with new functions of their need. This is now the most used web server.

Von Hippel means that the democratic innovation is where actual users a solving their own problems by mutual sharing their needs and solutions.

2.3.5 Examples of products starting in the needs of individuals with disabilities

Self-opening doors are an example of solutions where all benefit from the need of people who uses wheelchairs.

Figure 3 Doorway on tram

The needs of brooder doors and no stairs in trams were expressed by people, who use wheelchairs, and their needs. This was an accessibility demand to let the individual in the wheelchair travel as everybody else. But who is gaining if the tram train has broad doors so it is easy to access it and get on and off? It is probably more accessible for all commuters to make their way in and out of the tram wagon.

Yes, it is accessible for persons with disabilities **but** is it not equally accessible for someone that has a shopping bag on wheels, a person with perambulator and it simplifies life for all persons, not only in high traffic. This was actually designed from the beginning as a disability accessibility improvement.

Figure 4 Uniting grip blender

Another example is a water tap. Water taps that have two handles can be difficult to use for setting the temperature. With the uniting grip blender it becomes considerably simpler to get the correct temperature. The uniting grip blender was originally made as a disability aid. Is there anyone, who sees it only as a disability aid to day.

A Swedish design firm has made several good examples where the need of a special group has led to better products for everyone. They have a tradition to work on user-oriented, inclusive products and work environments, with a heavy emphasis on systematic user research, stakeholder collaboration and sustainability

The firm had a project where the aim was to make a better walking crutch. One detail was critical to be ergonomic; the handle on the crutch. They made it to fit the hand ergonomics in a design process where several prototypes were made and tested with people that had needs of using a crutch. This knowledge was later reused to make handles for mountain bikes. The target group for these handles was all people.

Another example from the same design firm is a bread-knife specially designed for individuals with hand disability. The knowledge from this design process was reused when designing ergonomically improved tea and coffee pots, where the target group is people who such pots it in their profession.

An approach to solve problems for people with cognitive disabilities was taken in Lund in the early 1990s. The intention was to create a personal digital assistant for differently abled users. A group of researchers in Lund's Technical University developed a multifunctional, multimedia PDA, which they gave the name ISAAC. It combined a pen-based computer, a digital camera, a GPS, and a cellular phone (both data and voice) into one unit. The intention was to wirelessly, set the unit in contact with a support center which could assist over the phone, based on pictures, position data. The PDA had a grayscale touch screen, which used symbols and pictures, avoiding the use of text as much as possible in the interaction with the user.

One of the functions was a personal combination of calendar and diary. It had the capability to combine pictures with GPS-data and other activity records in a form of diary. It was thought of as an aid to be used of individuals with communication difficulties to tell others of their experiences.

There were many results in the project, which was documented in the book "What ISAAC taught us" (Jönsson, Malmborg, & Svensk, 2004).

> *"Although targeted for a special application,* ***Isaac*** *has the potential for a much wider use. The emphasis on multimedia and communication puts* ***Isaac*** *in the forefront of PDA technology as an example of future personal computing." (Certec, 1994)*

In 2007 a cellular phone entered the market which had the capability to take picture, a built-in GPS, a touch display, software to make blogs on the fly etc.

Figure 5 To the left is ISAAC and the little one at the bottom right is a Mobil phone with GPS

2.4 My own experience

My one experience plays a big roll in my choice of research area. I started as a newly graduated teacher in mathematics and music in a school for pupils and students with development disability. In my struggle to make mathematics understandable for my pupils, I found two computers that our foreseeing principal had bought but no one had used until I came to the school. This was in the year 1987 and the computer we used was a Commodore 64. It was the game computer of this time. To load a program we used audiocassette tapes where the

programs where stored. The programs for the computer were only gaming programs, one word processor and one economic bookkeeping program. There was a printer connected to this computer and it made lots of noise when printing.

The school where I worked was a regional school for pupils from the obligatory Swedish school system up to students in the upper secondary school, all with development disabilities. The pupils in the obligatory school were from 7 to 17 years old. And in upper secondary school they were between 17 and 21 years old.

My goal was to teach mathematics in a way that was understandable for pupils. I tried to make the teaching as practical as possible. One of my strategies was to make computer programs that visualised the problem and made visual aid for solving the mathematical problem. The graphics at the time was not so very good, but circles and squares helped to visualise small numbers. One of the biggest mathematical difficulties my pupils had was around handling money. How much money do I need to buy this or that? Do I have this amount in my wallet? I did a very simple game to train this ability. It was around this, my thoughts of learning contra assistive techniques started. For persons that do not have the ability, could we compensate the difficulties for those during the time it takes to learn the strategy to solve the problem?

In 1996 I started working in a healthcare organisation, in an assistive technology team, whose aim was to compensate communication difficulties. My daily work was about adapting technology for solving individual communication difficulties. The person who needed some form of assistive technique always had a letter of introduction from a

medical doctor, occupational therapist or a speech therapist. The adaptation of the technology was always a team effort. The participators in the work process were a rehabilitation engineer, an educationist, an occupational therapist or a speech therapist. Sometimes, if the person was a minor the parents did participate in the process. I would like to state that the process was a user driven design process. The process has what I would describe as a "design for me" (Anderberg, 2006) direction because of the individuals' need in focus. The process was iterative until the adaptation worked or, in some very rare cases, we had to give up. But was it really a "design only for me" process? I do not think so, because the learning of one case often leads to a faster making for another. With more and more experience the team was better and better to solve communication difficulties. One of the tools that came up was a prediction system. This system spread widely in the organisation and became something not only people with disabilities used. The system went from an individual to a "design for all" perspective solution.

This assistive technology team was engaged in a project (Mentek) run by the Swedish Handicap Institute around assistive technology for people with intellectual disabilities (Granlund, Mentek - Ett utvecklingsprojekt om begåvningsstöd för personer med utvecklingsstörning, 1996). In this project we (me and one of my co-workers) built an assistive tool for people who did not have the ability to work as cashiers in shops because of difficulties to count or understand the value of money. In section 6.3 this assistive tool is in one of the workplaces in the study.

Later that year I become the project leader for a project financed through the Handicap Institute and the Swedish national board of health and welfare. From the regional healthcare government participated an occupational therapist, special teachers and speech therapists. From 6 different municipal day-care centres for people with intellectual disabilities participated workgroups of persons with intellectual disabilities (employees) and their personnel. The project's aim was to strengthen co-operation between the employees from different municipalities and to raise the knowledge level within the different organisations of how to use this "new technology".

The use of Internet based chat and videoconference was a success, special the chat we used, the "Microsoft's comic chat". The success in this case was when working with individuals with autism. We could chat and learn how to express certain feelings in a non menacing way. I think that, even today (2008), using this chat technique, in learning for individuals with intellectual and/or autism is an area worth studying. The chat client is possible to use today (January 2008).It can be downloaded from the Internet address http://www.chat.org.uk/downloads/mschat.htm.

Figure 6 To the left is ISAAC and the little one at the bottom right is a Mobil phone with GPS

In 2002 I was involved, as an assistant project leader, in a project about what kind of adaptations or support people

with development disabilities needed to use Internet based services. This was the financed through the Swedish National Post and Telecom Agency (PTS). This project is described in section 5.1 and the result of this project is the single most important inspiration to this licentiate thesis.

Another inspiration was the project “spelhålan” (dungeon of gaming) in which the aim was to stimulate youths with disabilities to participate in computer games on the same terms as other youths. One of the activities in the project was to make a site www.spelhalan.se, which should describe how to adapt commercial games in order to make them accessible for players with different abilities. Another objective of this project was to make it possible for players with disabilities to play together, on equal terms with others in multiplayer games. The strategy for this was both to connect physical devices and to make it accessible as well as use software cheats. For example in a popular multiplayer combat game it is very hard for someone that does not have the cognitive skill to play together with others. We used a “software cheats” to give one player with cognitive difficulties more lives in order to make it harder for others to kill him in the game. In this way he could play longer and even become a valuable group member in a combat team. This project showed that it was possible for individuals with disabilities to play the same games as others.

One of the experiences from the project was the negative attitude of the possibility of accessing the game of persons around the youths with disabilities. (Hedvall, 2007)

A lot of the physical adaptation was used in this project; they were popular among others that tried the games in exhibitions that the project participated in and not only among youths with disabilities.

Today (2008) there is a game (WII) that uses this kind of physical activity as its main input. This attracts people from all ages to play together.

3 Concepts and Definitions

This chapter contains two parts, one that is about the human and one about the product.

3.1 Definitions from ICF

As a base for my reasoning about person's functions I use WHO's International Classification of Functioning, Disability and Health (ICF) (WHO, 2001). This taxonomy of ICF is a classification system of the functioning, disability and health in a broad perspective. Its intention is to describe aspects of human health and some health-relevant components of well-being.

> *"The focus is on all persons and not only persons with disabilities. The International Classification of Functioning, Disability and Health (ICF) is a framework and classifications that provide a unified and standard language by which people can describe health, and health related states." (Sykes, Health Classifications, 2007)*

In short terms ICF is a communication tool for describing individual health state in a life quality perspective. The framework of the ICF is organized into components:

Body; function –structure
Activity - participation

The body component is divided into two parts: body structure and body function. The body function is how the body works and the body-structure are how the body is anatomical. For example

Body function	**Body structure**
Mental functions	Structures of the nervous system
Neuromusculoskeletal and movement-related functions	Structures related to movement

Table 1 ICF body function and structure

The body function is both physiological and psychological functions. Body structure is the biological parts such as limbs and nervous system.

The activities and participation component includes all aspects of functioning in individual and societal perspective.

The contextual factors are divided into environmental and personal. The personal factors are not included in the ICF, but it is relating to these factors.

There is critique against ICF mainly because it is not easy to use the

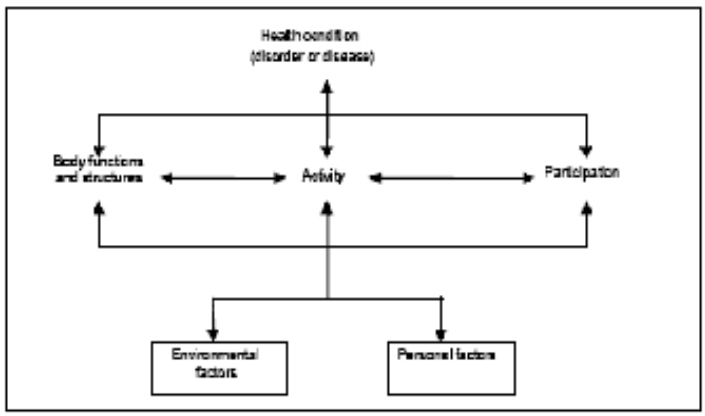

Figure 7 Interaction between the components in ICF

classification system. There is also critique about the lack of distinction of functioning and function (Kumar & Smith, 2005). Below I describe how I define the difference between function and functioning.

3.1.1 Functioning

The ICF functioning is defined as the state of the components: body-function, body-structure, activity and participation and how well they work together.

3.1.2 Functional disorder

Due to ICF a functional disorder means that there is a body-functional reduction, body-structure divergence, activity limitation or a participation constraint.

3.1.3 Disabilities

A lack of body function or a mental disturbance can for an individual make things difficult in certain situations. An individual can in that kind of situation be disabled. If the environments, services and products are well thought-out, on the basis of a "design for all" perspective, it increases the access possibility for persons with disabilities. Disability always occurs in relation to something or somebody and in a specific situation.

The term disability means that there exists a diagnosis on a body-function reduction or a lack of one or more body-functions. Disability is an umbrella term stemming from function reductions, structure discrepancies, activity restrictions or participation limitations.

3.1.4 Functional difficulties

The experiences of the everyday situation are individual. If products, services and environments are to be made out of a "design for all" perspective the accessibility should be better for more people. If we do not put all consideration on the difficulties of physical handling, difficulties of vision, difficulties in readability and reading comprehension, difficulties in hearing, cognitive difficulties, and instead focus on abilities and functionality in humans we increase participation and accessibility.

Most people experience some kind of difficulties some time in some place during their lifetime. The experience of a hampering situation can occur in all ages. Body damage as a broken arm, stressing situations or occasions where the person has understood the information wrongly

can be the cause of the experience. In these situations, there are no differences if a person has a defined disability or not, the experience of inaccessibility is the same, in other wordings the individual has some functional difficulties.

3.2 Terms for product/services attributes.

When discussing products and services there are some terms that are vital for describing their attributes. In this section I describe the most important ones, as I see them.

3.2.1 Usability

A product/service is relatively easily described on a basis of which functions it has. If the user has some use of the functions is a totally different question. This question is difficult to respond to if one not at the same time describes within which contexts the product/service will be used. When we talk about quality in ICT products and services we often talk about usability. Usability is defined in the standard for "Ergonomic requirements for office work with visual display terminals" Part 11: Guidance on usability. (ISO 9241-11, 1998)

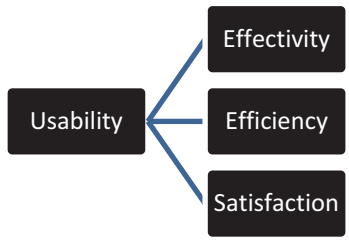

Figure 8 usability from ISO9241-11

> ***"Usability**: Extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use."*

Usability is further discussed in chapter 4.

3.2.2 Functionality

It is important in these contexts to distinguish functionality and usefulness. Functionality is something that shows which functions the product/service has, while usefulness is a measurement of how well the functions can be used.

If one is not attentive, a function specification for a product can be a way not to see the things that make the product/service lively, productive and desirable, namely the end-user (Borgström, Artman, & Holmlid, 2001). It is therefore very important that the function specification of the product/service is done from a user perspective.

3.2.3 Accessibility

Accessibility is a general term used to describe the degree to which a system (device, service, and environment) is accessible. It can also be described as the ability to access the functionality of a system.

Accessibility is often associated with disabilities and the right of access to a system. In, for example USA, Canada and Australia the individuals' access right laws and regulations is used to go to court to get precedent cases for others to lean on.

As described above accessibility is often associated with disabilities. For examples was accessibility defined in the Wikipedia encyclopedia December 2006:

> *'Accessibility is an idea that is used in order to describe how well an activity or premise functions for people with disabilities. This includes the premises' physical*

characteristic, the access to information and a good refuting'

Even in the W3S organization's Web Accessibility Initiative (WAI) (consortium, 2007) is implicated that accessibility is aimed mostly for people with disabilities.

It is easy that accessibility only becomes a question of physical access, but it can also be about things like access of the visibility, readability.

In a town in southern Sweden there is a sign showing in which direction the service offices are located. Well, the sign is accessible to see. But is it accessible to understand? The logotype, two arrows can be hard to understand. They could be interpreted as adverse directions or as indicator. This is not easy for anyone.

Figure 9 Sign showing direction of service offices

I will use this as an example to point out the difference between accessibility and usability. The sign is accessible to my sight but it is not to my understandings. The usability can not be measured since is not clear what the effect should be.

4 From Usability to Useworthiness

"Easy to use" is one of the main targets in the usability area. When designing new ICT products or services, there are a couple of ways to approach the usability area. One of the ways is to see usability as an attribute, as in ISO 9241 (Smith, 1984) (Mayhew, 1992), of the product or services, and another is to see it as a design approach, as for example in usability engineering (UE) (Tyldesley, 1988) or the user-centred design (UCD).

4.1 Usability in design

Usability is very often brought up late in the design phase of a product or services (Jordan P. e., 1994). Usually the result, with this method, is not benefiting the user of this version of the product but the next. A Japanese group (one was Toyota) worked with a method called Quality Function Deployment QFD (Andersson, 1991) in the 1970s. The method focused on the users' and other stakeholders' demands, wishes and desires. AT&A used this method to measure customer satisfaction (Thompson D, 1989). They made a survey before they started the design process and the outcome was easy to measure against.

Partly the same ideas are the thoughts behind usability engineering

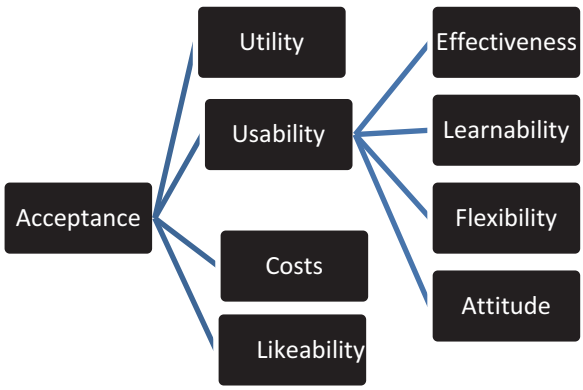

Figure 10 Acceptability by Nielsen

(UE) (Tyldesley, 1988) (Nielsen J. , 1993). The main difference between UE and QFD is that in UE the user or someone representing the user is present during the whole process and in QFD the user is only involved at the start. Nielsen is advocating using as few as 8 -10 individuals in a "discount" usability test for getting hold of up to 80% of the usability problems with a product (Nielsen J. , 1994).

According to Shackel (Shackel, 1991) usability is not a constant property because it is depending on context. The user can for example have different levels of training, levels of support and different environments, which influence their view of usability. In his approach of product perception, acceptance is the most important part. Acceptance is the sum of utility, usability, cost and likeability.

4.2 Quality of use

Usability is in Bevan and Macleod's (Bevan & Macleod, Usability measurement in context, 1994) discussion seen as *"a property of the*

overall system; it is the quality of use in a context". Working practices, location, appearance and differences between users are some of the attributes of the overall system. They point out the importance that attributes of the product only are one of the contributions to the quality of use. Bevan states that the objective of usability is the "quality of use" and that this is something that has to be considered during the entire design work (Bevan, Measuring usability as quality of use, 1995) (Bevan, Usability is Quality of Use, 1995).

4.3 Measuring usability

In measuring usability, according to Shackel, there are two sides to take into account: the objective interaction and the subjective perception of the product. Shackel also recognises some aspects of operational criteria that can be measured; effectiveness, learnability, flexibility, and attitude.

Usability can be measured by this definition as how well the product/service achieves a specific objective. This will also tell us how effective the product/service is; apart from this it also points on how the user experiences the service/product.

The last part, user satisfaction, is difficult to evaluate with a technical point of view. In the ISO 9241-11 standard satisfaction is defined as the absence of discomforts and the positive attitudes for the user. Nowadays it is interpreted as comfort and acceptability. The Swedish translation of satisfaction is more about reflections of rationalized and logical reactions. The criticisms of this are that a human is not only an individual, an object governed individually without feelings. How the user feels in contact with the product should be used in the

development processes (Jordan P. , 2000) and it is a very important factor when designing products for humans.

Nielsen talks about products' usefulness (Nielsen J. , 1993) which gets its input from utility and usability (Grudin, 1992). The utility is the actual product's functionality in principle in terms of if it can actually do what it is intended to do. Usability is then all aspects where it might interact with a human.

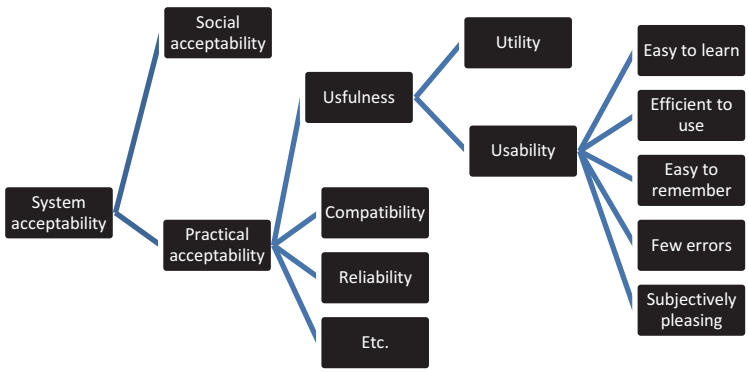

Figure 11 Model on system acceptability, according to Nielsen

Usability measuring is an area of big interest. In Nielsen's "Usability Engineering" (Nielsen J. , 1993) he discusses the area of usability measuring. Overall his suggestions are to use the time factor to give a value to usability. For example the "easy to learn" is how long time it takes for a user to learn the system. Efficiency to use is measured as the time it takes to do a certain task for an experienced user. Almost the same arguments are used to measure "easy to remember" and "few errors".

The usability attribute of satisfaction is different according to Nielsen. He means that this is especially important for non-working environments. One of the difficulties he is pointing out is that the user often relates his/her satisfaction to a peek level experienced difficulty and not to the mean level difficulties.

4.4 Useworthiness

Håkan Eftring coined in his dissertation 1999 "The Useworthiness of Robots for People with physical disabilities" (Eftring, 1999) the word "Useworthiness". He describes "useworthiness" as a more user centred term. It is the users who can decide and no one else if a product or services are worth using. This is one of the main ingredients of the term "useworhtiness".

With grounding in Nielsen's (1994) usability tree Eftring has enlarged it with "User's high-priority needs" and replaced "usefulness" with "useworthiness"(Figure 12).

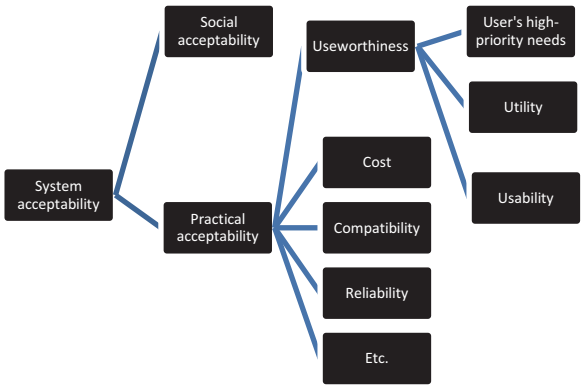

Figure 12 Useworthiness comprises utility, usability, and the user's high-priority needs by Eftering

Analogous to this is the example about a book. The book is readable, yes, but is it worth reading? The only one that can decide this is the reader and then the big question is: Who is the reader?

5 Persons with functional difficulties in usability projects

In this chapter I will describe some of my practical experiences of working with persons with functional difficulties in usability project. In section 0 I will describe a project that has been one of the start points of my thoughts of using individuals with functional difficulties as a resource for identifying difficulties. In section 5.2 I describe a model of design (TED), where I have been active in the development.

The last part, section (5.3) is a practical example of almost the same ideas as in the TED-model. I have been part in executing some tests and I have also been a member of both the Swedish and the European groups of standardisation for “The easy of open packages” which was drawn form this test methodology.

5.1 PTS and TED - projects

The TED model (described in section 2 in this chapter) has arisen as a result of a project from the Swedish Post and Telecom Agency (PTS), a study in Bollnäs and Gothenburg. The aim of the study was to identify what kind of support and adaptation of broadband services that people with intellectual disabilities need. In this study a special school (Höghammarskolan) for students with intellectual disabilities and an association in Gothenburg, Grunden, where all the members are people with intellectual disabilities, participated. Altogether 16 persons with intellectual disabilities participated.

The first thing the study did was to let the participants identify what kind of broadband based services they were interested in. The result of this became a list of services. Then all the participants scrutinized the services to find out if they needed adaptation or support, and in that case what kind in order to use those services.

Another project started in Bollnäs, where one of the objectives was to reflect upon usability issues, accessibility issues and utility aspects (services worth to use) on broadband service. This project was a regional collateral project called TED (Test, Evaluation and Design). The participants in the TED project were 14 self employed Bollnäs citizens and 27 participants from a health care centre in Bollnäs. Most participants were inexperienced users of broadband services.

The participants scrutinized the same broadband services as the PTS project. The result pointed in a very interesting direction. In the PTS group the participants pointed out the difficult or non-understandable

areas very quickly but the TED group stated at first that there were no areas that were difficult or non-understandable. But when pointing out the same areas as the PTS group had identified as difficult or non-understandable the TED group answered:

- I didn't observed that condition
- It was so difficult that I skipped it
- Yes, it seems to be difficult
- I didn't realize the benefit of it

Other areas where the two groups had the same answer were:

- Log on procedure, order broadband connection
- Install broadband on own computer
- Make necessary adaptation of own computer
- Contact customer PC support,
- Contact customer broadband support.

This led to the question: Are people with functional difficulties better in observing/identifying usability problems?

5.2 TED - Model

The development of the TED model started from an urgent need of having different end user target groups involved in the testing procedures and design work concerning information and communication technology services. The model is compliant to ISO-standard 13407, asserting four user centred design activities that need to start at the earliest stages of a project. These are:

- Understand and specify the context of use
- Specify the user and organizational requirements
- Produce design solutions
- Evaluate design solutions against requirements.

A conventional model of usability testing in a user centred design approach, which does not consider users with specific difficulties (see Figure 1), is not sufficient for designing usable and use-worthy services for a broad majority of users.

The basic difference compared to a conventional usability model is the introduction of an indicator group consisting of people with specific difficulties, who are thought of as problem identifiers in the evaluation process, and a creative solution asset in the design process of new products and services.

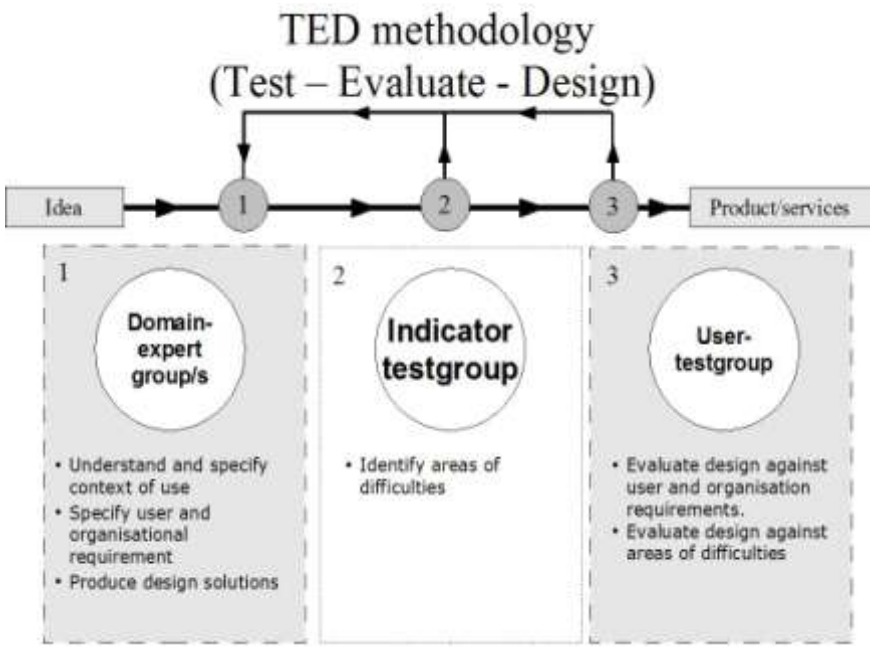

Figure 13 TED model

For example, if the aim is that the product should be easy to understand, the indicator group should include people with difficulties of understanding; if it should be easy to read, then the indicator group should consist of people with difficulties to read, and so forth. This method is not only covering the usability issue; but also the accessibility issue; if the indicator group is chosen with care. Putting together the indicator group is the difficult part.

Part one in the model is where the collection of information in order to understand and specify the context of use is done. One of the most important steps for a design team is to gain a good qualitative understanding in order to be able to go further on with the task of designing. If the purpose is to evaluate a product or services, the

evaluation is standing on a solid ground when the design team has good qualitative understanding of the use context. It is very important to get hold of a variety of users. All stakeholders that will use the product or services directly or indirectly are in this case included in the group of users.

Part two in the model is to catch the difficult area of the product or services. It is in this part the usability attributes as in "the quality of use" (Bevan & Macleod, 1994) must be clarified as a background for to choose the members of the indicator group. If the usability attribute of "easy to….." is not clarified then a broader selection of members with different difficulties should be chosen.

This model does not stipulate the catching method more than using people with difficulties as indicator group.

Part three in the model is the part, where the product or services is evaluated with individuals from the targeted user group if the usability goal is achieved. Most important is to evaluate the areas of difficulties that were gained from part two in the model.

Then there is iteration of the three parts until the product or service has achieved a satisfactory result for the client.

5.3 Swedish Rheumatic association test methodology

"Ease of opening" of consumer packaging is an important issue for all consumers but it is more important for people with limited abilities in their hands. If people with limited hand functioning consider a

packaging to be easy to open then all people with better hand function would also consider it easy to open. The Swedish Rheumatic Association (SRA) has used this for making an approach to put pressure on the producers in order to get easier-to-open packaging on the Swedish market.

The SRA has put in place a usability test and if a package passes the test then the producing company can label the package with a symbol, where the SRA states that this is an easy to open package.

The test uses a test panel consisting of people with limitations in their hand functioning. The panel must include people with different grip difficulties (tweezers grip, key grip, chuck grip, five finger grip, diagonal volar grip, transversal volar grip) and hand functions (physical strength, coordination of the movement, trembling, perception of touch). Each test panel members should have difficulties or severe difficulties in one of their hand functions and/or with at least one of the grips.

Figure 14 tweezers grip

Figure 15 key grip

Figure 16 chuck grip

 Figure 17 five finger grip	 Figure 18 diagonal volar grip	 Figure 19 transversal volar grip

The method for the test is close to the approach of experimental design (McBurney & White, 2004). The primary objective for methods based on experimental design, in industrial settings, is to extract the maximum amount of unbiased information regarding the factors affecting a production process from as few (costly) observations as possible. By following this kind of test design the test panel can be kept minimal.

The test for the current packaging is made with a group of 18-28 persons with limitations in their hand functioning. The test is done by asking relevant questions from the question list. The question list consists of six questions:

What is it like to:

1. open the package the first time?
2. take the right dose/amount from the package?
3. close the package?
4. open the package a second time?
5. empty all content from the package?
6. What is your overall judgment of the “ease of opening”?

By referring this group’s results to results from a bigger reference group of about 100 individuals with limitation in their hand functioning, the

result is made more consistent. Both groups have tested a certain packaging by answering the five first questions from the question list. Then the comparison of the result for the current packaging is made with this result.

The overall idea is that using people with difficulties to perform the usability test should enable a valid result also for people with better hand functioning.

6 Empirical studies

This chapter describes two studies. The first one is about five cases of designing web sites. The second looks into three different work places with different levels of technical aiding support. The individuals that participated in this study had development disability.

Both studies are made in conjunction with the TUD-model (described in section 5.2). An indicator group with individuals with development disabilities was used in study one. The studies were made to find areas of difficulties that could be of more generic type.

6.1 Background for the studies

Developmental Disabilities is defined by J.P.Das from the Diagnostic and Statistical Manual of Mental Disorders, American Psychiatric Association (Äystö, 1993) as

> *"...disabilities that affects a range of social and cognitive areas including communication, learning, judgment, and interpreting and responding to social cues..."*

Intellectual disability is a wider group than development disabilities. Development disability means that the disability has emerged before the age of 22. A common definition of development disability is that the IQ should be below 70, which means it should be measured as 70% of a normal cognitive development (Kylén, 1996). This is mostly used in Sweden today for decisions for whether individuals have the right to receive governmental support or not.

The Kylén model is more than just measuring IQ. According to Kylén, you have to collect information about the individual's sensory impression of space, time, quality, quantity, and cause (cause and effect) in order to make a broader description of the individual. He is also using four abstraction levels on the thinking process, structuring and symbolization (Kylén, 1996). These levels are related to approximate ages as follows

- Level one 0 - 2
- Level two 2 - 6
- Level tree 6 - 12
- Level four 15 -

Another way of describing the individual needs of support is the PASS model, Planning (P), arousal and attention (A) and sectional and simultaneous (SS), that is used in Finland. This practically aimed model is developed for cognitive assessment and planning. This is not a model for categorizing cognition disability; it is a way to visualize the individual needs. The aim of this model is to focus on how to compensate the individual difficulties in the neuropsychological model (Äystö, 1993). A refinement of this model is referred to as a neuropedagogical strategy, which can be used in vocational training (Adler & Holmgren, 2001). The strategy builds upon the knowledge of the individual difficulties of cognition and tries to find a positive way to tackle the difficulties. This strategy for assessment is close to the spirit of ICF (WHO, 2007), from WHO, which applies a holistic view of the individual. The important thing is to look at the individual's life quality (Socialstyrelsen, 2003).

6.2 Study of a design method when develop web sites.

In order to make a web page easy to use we have to know what we mean with "Easy to use". Is it just easy to navigate physically or is it easy to understand or easy to read it. To make a simple and effective navigation system in a website is one of the most important things to make it user-friendly.

We can approach the question in several ways. One is to involve the target users in the design process. This has been successful in UCD and in the co-operative design process (Bødker, Ehn, Sjögren, & Sundblad, 2000). Co-operative design was used in the project "KidStory" (Taxén, Druin, Fast, & Kjellin, 2001). The children where equal partners in the workgroups. The workgroups were building low tech prototypes with focus on usability issues and innovation.

Is it possible to make easy to use web sites? Well, it should be, but where do we start. One strategy is to start with the most difficult part. But which one is the most difficult?

This small study was made as a very simple test if people with development disability can be of help in finding difficult areas in the design and in making the results more understandable.

What happens if we let people with defined difficulties, not statistically chosen representatives of the user group, take part in the early stages of the design process?

6.2.1 Aim

The aim for this study was to sharpen the TUD-model to be more accurate. This study had its focus on making the usability issue simpler to deploy in the design process of making web sites.

The main research question in this study was:

> *How does the use of indicator group influence the design process?*

The secondary research question was:

> *In which way do individuals with development disability richer the development of easy to use websites?*

6.2.2 The sites in the study and theirs target groups.

Site 1

This site was aimed to promote a conference. The target for this site is politicians, organizations, companies and all other interested in the area. Target users for this site is all citizens in the county for the conference.

Site 2

This site was aimed to make pressure on manufacturers for certain consumer products. The target group is manufacturers and the entire group of consumers, but mostly aiming for consumers with a specific limitation of their physical function.

Site 3

This site is going to be a place for public information from a certain municipality. The target user is all citizens in the municipality. The aim from the municipality is that the site should be made in a "Design for all" perspective.

Site 4

This is for a site that is intended to bring easy and understandable information to the guest of municipality old-age care and the guests' next of kin. This site should work both on a computer and on set top boxes for TV.

Site 5

This site is aimed for a small web shop with a limited number of products. Target group is all consumers that have access to internet.

All sites in this survey are aiming towards ordinary users. There is a difference in site 4 where the target user is elderly people that are in old-age care. This implicates that target group has severe difficulties due to the system of old-age care in Sweden, where elderly people live in their own homes as long as possible. The difficulties can be both of psychiatric and of physiological nature.

6.2.3 Method

The study was made using paper based prototypes of the web sites. The usability area of this study was mostly in the area of "Ease of understanding". Real navigation at the sites was not possible due to the designing phase, where not all of information in the sites was available during the testing. This was the first step in the development process to give the web designer some input on the layout and how understandable some of the conceivable functions were.

The method used for evaluation in this study is based on "Think aloud" (Lewis C. , 1982) (Lewis & Rieman, 1993). The method's main purpose is to let a user describe how to do a specific task. The user is also expected to verbally express his/her thoughts. Talk-aloud (Ericsson & Simon, 1984) is a closely related method that enables teachers to follow a person's learning strategy.

An aim is to let the participants express themselves as freely as possible and to let them talk as much as possible from their own point of view. Another aim from using this method is to follow the individual's strategy of using the site. The entire test was made in two steps;

First, we asked the participants to "Think aloud" while he/she was looking at paper prototypes. The participants were individually asked to describe how you navigate through the system and to describe their thoughts would happen when navigating through the system as the first part of the test.

Second, the participants worked in a workshop where they made a simple prototype. In tests of sites number 1 and 5 there was one more iteration. The web designer presented new paper based prototypes for the participants. The participants were then asked to "Think aloud" about both prototypes and asked for which they prefer and why, as step one?

6.2.4 Participants

The study was made with one indicator group (Ohlsson, Persson, & Östlin, 2005) (Ohlsson, Persson, & Östlin, 2006) with individuals that have a development disability and one control group with elderly people or a control group with school employees.

The individuals in the indicator groups were in the ages between 17 and 20 years old. The indicator group participants were 60% female. All the participants were used to mobile phones, Internet and chat. None of the participants indicated that they were technique novices.

In each site study there were between 6 and 9 participants in the indicator group. Three individuals participated in two different site studies. The total numbers of participants in the indicator groups were 35 individuals.

One kind of control group was recruited with elderly people in the ages between 63 and 86. In this group there were 55% female and as high as 25% of the individuals indicated that they were technique novices. One of the elderly control groups of 6 individuals participated in two site tests. The total number of participants, in the elderly control groups (E), was 14 individuals.

Participants	Site 1	Site 2	Site 3	Site 4	Site 5
Indicator group	9	6	6	6	7
Control group of elderly people (E)	6	6			8
Control group of school employee (S)	4		2	3	4

Table 2 Participants in Web development study

Another kind of control group was recruited with adults working in a school. Half of the participants worked as teachers and the other half worked as teacher assistants, without academic education. Nine individuals was participating in the School employee control groups (S), out of them only two were male. Two individuals indicated that they were technique novices.

6.2.5 Result

The result of this study is done in two parts for every site. The first part is a description of the outcome objectives of the two steps in every site study. The second part is a table of step one and a comparison of the result from the indicator group with the one or both of the control group/groups of both steps of the study.

Site 1

The menu of this site was located at the top under a logotype. One of the things that all participants made remarks about was that the size of the menu font was too small.

Eight out of nine in the indicator group, four out of six in the E-control group and the entire S-control group pointed out that the text and the menus were difficult to read because of the text colour. All were red.

That the menu options were easy to understand was something that all the participants agreed about.

In the workshops with all groups they suggested that the menu should be larger; this would make it easier to find. It also would be good if the menu colours were different from the ordinary text.

The indicator group also talked about that it should be easier to understand which menu item you are about to choose if it had been indicated in some way. This did not come up in any of the two control groups (this was included in the final version of the site). In all groups there were discussions about the colour around the information area.

A new prototype was made taking into account the comments that the groups had made. The menu became bigger and a mouse-over function was added. The ordinary text was black and the menu was made red.

The indicator group and the control groups were asked to test a working prototype on the Internet. They were presented to the same paper prototype as they first had seen and they were asked to compare

Area of remark	Indicator group	E-control group	S-control group
Small menu text	100%	100%	100%
Text colour	89%	67%	100%
Understandable menu items	100%	100%	100%

Table 3 Result summary of site 1, the individual comments sorted in groups

the paper prototype with the Internet version. All groups found that the changes were better. The control groups all agreed that the menu size and the mouse-over function made it very easy to choose the right menu item.

In this test almost all individual comments were similar. One interesting thing was that two out of six of the participants in the elderly control group not did mention text colour. The others in this control group strongly pointed out the difficulty of reading red text. The major difference that came up, in the group activities, was that the Indicator group pushed the need of a simplified system to know which menu item

that is about to be pressed; a form of awareness functionality. This was not a suggestion in any other group. The other groups were more stuck to the designers' proposal.

Site 2

All participants, both in the indicator and in the E-control group expressed that the menu was easy to find. All participants talked about that for some of the menu items it was hard to explain what it was supposed to mean. How to vote, was something that all individuals in the indicator group and four individuals in the E-control group, had difficulties to describe.

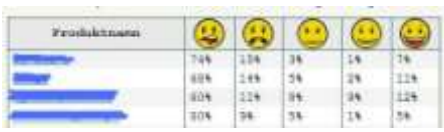

Figure 20 Result view of consumer voting site

In step one, the individual part; all the participants in the indicator group had trouble understanding the voting results. Four of the participants in the E-control group also had difficulties describing what the result meant.

All individuals in the indicator group had trouble with the pictures; they tried to give them some functionality. Three individuals in the E-control group also did the same thing. The designers' thoughts of the pictures in the prototype were something that should emphasize the message of the site and not be any function connected to them.

In the group activities both groups preferred a cleaner layout. They also recommended making a simpler way of doing the voting. The groups also suggested that the visualizing of the previous voting result should be shown before the individuals voting.

That the menu text could be bigger was something that both the indicator group and the E-control group recommended in the group activity.

Area of remark	Indicator group	E-control group
Menu easy to find	100%	100%
Difficulties to explain meaning of menu item	100%	100%
Difficulties of how to vote	100%	67%
Understand the voting result	100%	67%
Describing picture function	100%	50%

Table 4 Result summary of site 2, the individual comments sorted in groups

The individuals in the indicator group were very homogenous in their comments. The elderly group differed more in their comments. In the group activity both groups discussed the same things. There were very hot discussions about how the voting result should be shown and there was almost the same suggestion from both groups.

An interesting thing was the difference between the individual part and the group activity part about the result of voting. In the individual part there were some members of the E-control group that did not mention anything about the voting result but when they were in the group activity the same person strongly argued for how it should be shown.

Site 3

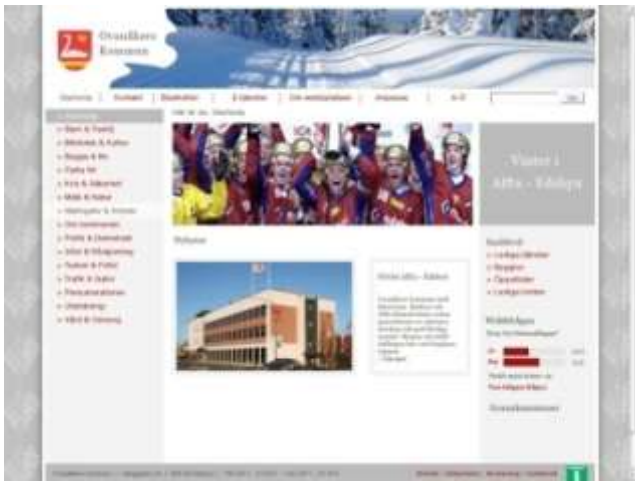

Figure 21 Municipal web site

All participants in the indicator group reacted to the menu text and the menu background colour. They expressed from "only difficult" to "very difficult" about the menu item colour. The S-control group did not mention this at all.

Both groups reacted to the size of the menu text: too small. Another thing that came up in step one, for all individuals in the indicator group, but not for the individuals in the S-control group, was the question about which menu that was the head menu.

All participants did notice the slightly coloured background in the side menu and five in the indicator group asked if these were supposed to mean anything.

The paper prototype was presented as three papers from different menu levels of using the menu. At the end of the individual part we asked how they recognized under which menu they were. Below the

head menu there was a field, which shows where in the menu system the user is at the moment. For example "startsida/utbildning/grundskola" means that you have chosen "utbildning" from the "startsida" menu and "grundskola" from the "utbildning" menu. No one of the participants could answer this question.

The designer of the menu had an intention that the upper menu should change depending on the user's choice from the left side menu.

In the group activity both groups discussed and gave a suggestion that the text colour should be black or any other dark color. There were also discussions about the menu system and a couple of suggestions on how to solve the logistics around it were described.

In the individual part the participants in the indicator group and the S-control group were very homogeneous in their individual description and which questions that came up in each group. There was a significant difference between which questions that came up in the indicator group and in the S-control group.

In the group activity both groups discussed almost the same issues even though the S-control group, in the individual part, did not bring up the questions around menu text and background colour and how the menu system worked.

Area of remark	Indicator group	S-control group
Questions of menu text and background color	100%	0%
Size of menu text	100%	100%
Which menu is the head menu	100%	0%
Questions about navigation awareness in the menu-system	100%	100%

Table 5 Result summary of site 3, the individual comments sorted in groups

Site 4

The prototypes in this case were shown as two proposals delivered by the web designer. The prototypes had a total of 9 pages of paper. The main medium for this site was the TV. The navigation was supposed to be made by using a certain handheld controller together with the set-top box. So in the individual part all the participants were introduced to the handheld controller and to the paper prototypes.

Figure 22 Remote controller

All participants in the indicator group could explain how to navigate by pointing at areas in the prototype. Five out of six individuals in the indicator group had a clear view on how to navigate with the handheld controller. This differed, unfortunately for the designer's idea of how to navigate. The participants in the S-control group explained how to navigate, in the prototype, the same way as the participants in the indicator group. Two out of three in the control group explained how to use the handheld controller with the prototype in another way than the designer's way.

Figure 23 TV interface in Municipal old-age care.

Both the indicator group and the control group suggested in the workshop that the navigation with the handheld controller should use the same idea as when you navigate on the Internet. To use the arrows up and down to put the marker on the object that is to be changed. The right and left arrow should be used to change the values and to decide with the "OK" or "enter" button on the controller.

The designer's idea of navigating was to use the number buttons, on the handheld controller, in order to change the top menu. By using the left or right button it was possible to change the middle menu (activity) and by using the up and down arrow it was possible to make changes in the right menu (activity).

In the first step, the individual part, all individuals in the indicator group and one individual in the S-control group were unsure what the green tick and the red cross meant. They could not decide if the cross or the tick were the symbol that meant that it had occurred.

Figure 24 Menu example of Municipal old-age care TV page.

The idea of the designer was that the tick was something that should happen or had happened and that a cross indicated a canceled activity.

Figure 25 Menu example of Municipal old-age care web page.

The design idea was that the user should recognize the layout on the Internet as the same as on television. The main difference between TV (figure 24) and the Internet (figure 25) was that the entire month days, as an example from 1 to 31, was shown just below the head menu as shown in the Internet version. No one in the indicator group did know what the numbers meant and only one in the S-control group could described it.

In the group activity in step two both the indicator group and the S-control group were satisfied with the layout as it was.

In the individual part all the individuals in the indicator group were rather homogenous in which questions they brought up. There was one individual in the indicator group that had difficulties in doing a logic connection between the paper prototype and the handheld controller and therefore this individual had difficulties in doing the task.

There were more different questions brought up in the S-control group and pointed out as difficult areas.

Area of remark	Indicator group	S-control group	comments
Clear view of how to use handheld controller with the menu	83%	100%	No hence taken if the strategy was right
Menu strategy differ from the designer way	100%	67%	
Unsure of the meaning of some used signs	100%	33%	No hence taken if the meaning of the signs was right
Could describe what a row with numbers in the menu meant	0%	33%	
Easy to find menu	100%	100%	

Table 6 Result summary of site 4, the individual comments sorted in groups

Both groups gave the same suggestions of how to navigate the menu with the handheld controller in the group activity. All the individuals in the S-control group did not make any individual marks on the use of the signs, tick and the cross but in the group activity they all discussed how to and ways to use some sort of signs. The indicator group also discussed this issue.

Site 5

All participants reflected in step one (the individual part) that the menu system was easy to find. That the menu text was too small in relation to other text was also pointed out by all participants in the indicator group, in the S-control group and four out of eight in E control group.

All the individuals in the indicator group, seven in the E-control group and two of the S-control group indicated problems with some of the words used in the menu. The word they had most problems with was "portfolio" and how to understand what should happen if this item had been chosen. Other words in the menu were "pallar" (Swedish for footrests) and "leksaker" (Swedish for toys). For one individual in the E-control group the word "pallar" was something he connected to pallet and not to something you would like to have indoors.

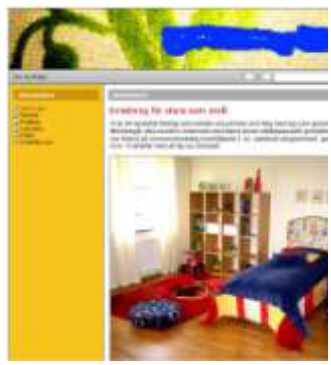

Figure 26 Web shop, start page

For three individuals in the indicator group and two in the E-control group the menu item "nyhet" (news) was linked into their thoughts of news in a newspaper or on the TV.

All participants had trouble describing how to do the shopping. In figure 27 there is shown some products to buy. The customer is supposed to click at the picture of the product to get to a page were it is possible to buy a product.

Figure 27 Merchandise page, web shop

In step two of the group activity there were only two suggestions from the three groups; larger text in the menu, and a button beside the picture of the product so it is simple to buy things from the site.

After the group activities all the groups, separately, were offered to try a working prototype on the web. They were asked to buy a product. No one of the participators did finish the task. They could not find out how to buy a product.

The indicator group was rather homogenous in the individual part. The only issue was about the meaning of a word, which could depend on the level of language knowledge for some individuals in the group.

The strange thing was that the same difficulties also occurred in the E-control group for the same word. This could also be explained in the context of use of the word “nyhet” (news). In the group activity this issue was straightened out in all the groups.

Area of remark	Indicator group	E-control group	S-control group
Menu text to small	100%	50%	100%
Difficulties of understanding the words used in the menu	100%	87%	50%
Described another meaning of the word “nyhet”(news in English) in the menu	43%	25%	0%
Described another meaning of the word “pallar”(footrest or pallet in English) in the menu	0%	One individual	0%
Describe how to do the shopping	100%	100%	100%

Table 7 Result summary of site 5, the individual comments sorted in groups

Another area of disagreement in the individual part, between the groups was the size of the menu text. The strange thing was that in the E-control group only half of the individuals thought that the size was too small. But in the group activity all the members of the E-control group agreed that the menu size should be larger.

Result summary

The aim for this study was to find out how the use of an indicator group influences the design process and to describe in which way individuals with development disability can enrich the development of easy to use websites?

The first question about how indicator groups influences the design process can be illustrated by the following.

- *The method of using simple paper prototypes and to let the participants individually talk what they are thinking seems to be very efficient. Especially the individuals with development disability were very focussed when doing the "think aloud" activity. The other E- and S- control groups did not have the same focus in the individual parts and they seemed to have some form of psychological barrier against saying what pops up in their mind.*
- *It seems like the group of individuals with development disability has very easy to think aloud around the paper prototypes. For the individuals in the S- and E- control groups it takes some time to get started.*
- *I have also noticed that it takes significantly longer time per individual in S- and E- control groups than in the indicator group.*
- *In the group activity the difference between all three groups is not so big. It seems to depend more on the group members' way of interacting with each other.*

The second question was about in which way individuals with development disability could enrich the development of easy to use websites?

- *The indicator group's members had a wide range of suggestions mainly in the group activity for improvements that were of the kind that all individuals with or without disability could take advantage of the suggested proposals.*
- *Even small difficult areas were noticed by the indicator group, but not in the other groups.*

6.2.6 Discussion

One result that was surprising to me was the ease in which the indicator group talked about how they perceived the tested prototype sites. This method of "think aloud" with paper prototypes seems to be very effective for the indicator group. The control groups did not seem have the same immediate ease to talk about what they perceived about the prototype pages.

The comments from individuals in the indicator groups were more homogenous than the individuals in the E- and S- groups. In almost every question the indicator group members described the same difficulties. The E-group had larger amount of life experience, which resulted in almost every study that someone put forward a unique point of view.

Also the S-control group was more individually varying in their comments and reflection compared to the indicator group. This could depend on that the participants in this group were varied in educational level and in life experiences.

The indicator group's impact on the usability issues was actually mostly in the area pointed out in advance; the area of understanding the sites. The understanding of the text was one of the areas of understanding the indicator group had a lot of comments about, probably because it is something that is important in their lives.

One other area that also was getting comments on the usability issue from the participants was the logic of the menu system of the prototypes. The method "Think aloud" was probably a very good way of

getting direct indication on the logic of the menu system. The members of the indicator group have, within their defined difficulties, probably the answer why they so effectively point out the difficult parts of the menu system. They pointed it out by not describing what the menu item should mean. The members of the control groups tried to describe all menu items even if they did have a feeling that it was a guess. This could be one of the things that make the use of indicator groups effective.

With a "design for all" perspective in mind the result is pointing out, that by having people with difficulties in the test/design groups problems within the area of accessibility are automatically included in the process without having to include them separately. This was very obvious in those cases where a second prototype was presented.

I am wondering what would happen if this kind of method was used even earlier in the process. If we look in the ISO 13407 standard (ISO 13407, 1999) for the steps of "understanding and specifying the context of use" and when "specifying the users requirements" could the indicator group contribute also to this parts?

6.3 Workplace studies - cashier situations

This chapter is based upon a research case from different cashier situations. A part of this research has been sent in to the conference wwcs2007 in Stockholm as a short paper under the title

"Computer as a vocational helping tool, Working in a shop - a dream comes true"
(Persson, Pettersen, & Ohlsson, 2007)

For people with development disabilities working in a shop, the handling of money is usually difficult. For those who cannot count, the handling of money is out of reach without access to an aiding tool. For those who can count, the stress of the situation could make it much more difficult to manage the situation.

6.3.1 Background

The present study was made at three different workplaces. In one of the workplaces there is a cash register, designed for people with development disability.

In the middle of the 1990s there was a project by the Swedish Handicap Institute (HI) called "Mentek". The "Mentek" project was aimed to bring knowledge of using new technology as a helpware for people with intellectual disabilities. The result of this project pointed out empowerment as the main gain of using these kinds of technologies (Granlund, 1996). A part of "Mentek" was about what computer based working tools could do for people with development disabilities. One scenario was about all kinds of tasks at a café. Is working as a cashier, in a café or a shop, a job only for those who can count and know the value

of money? The development of a cashier tool was made in the project. The tool was designed according to the users' needs. By engaging users in the design process, not only as test-persons, but also as an important part to engage the designers and developers better understanding of the use contexts and situations was gained (Jönsson, Malmborg, & Svensk, 2004). This tool (software) was used in one of the settings.

6.3.2 Aim

The TED model is a method for investigating which are the difficult parts in a product or services. The main research question in this study was to find the difficult part in the three work environments. The secondary research questions were:

- How do different supportive assisting techniques affect the work and the workers, and
- Is a low-tech solution better than a high-tech solution?

6.3.3 The Study environment

For people with development disabilities working in a shop, the handling of money are usually something difficult. For those who cannot count, the handling of money is out of reach without an accessibility tool. For those who can count, the stress in the situation could make it difficult to manage the situation.

The Study was made in three different workplaces, where people with development disabilities worked as cashiers.

A model of supported employment is practically used in these environments. The customers in all the settings are mostly college and secondary high students and employees of small companies. The working place is using a model that emanates from 'Supported employment', where tutors act as facilitators for the new workers in their new working place. This is a successful process (Antonson, 2002). The main goal of the tutor is to help the workers to become as independent as possible.

The phases in the cashier's work can, with some simplifications be described as three phases:

- Calculate what the customer should pay for the selected merchandise.
- Calculate if the money handed over from the customer is sufficient for the selected merchandise.
- Calculate how much money to give back to the customer.

The description of the three workplaces:

Figure 28 Shopping tray

The first workplace is one where the workers are using a shopping tray at customers' working places. They are only using a cash box and the workers are counting in their heads or using a calculator. There is limited stock on the shopping tray. It is mostly sandwiches, fruit, candy and soft drinks. The workers do the same tour every working day. There is always a tutor present (W1);

Figure 29 old fashion cash register

The second workplace consists of an ordinary shop where there is an old fashion cash register with feedback to the cashier through text and numbers on a display. They have to use a barcode reader or type in the merchandise's article number. The shops merchandise is almost the same as in a supermarket, but with no food (W2).

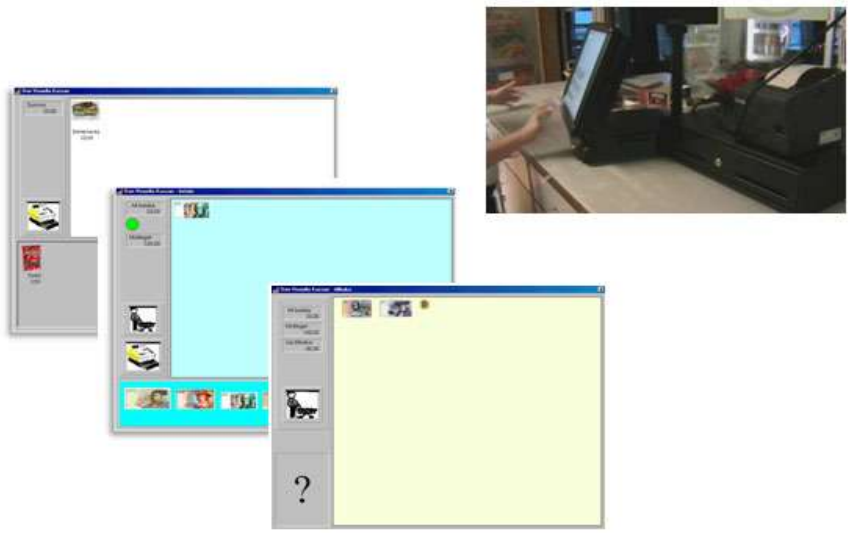

Figure 30 Cash register specially designed to make it easier for people with intellectual disabilities.

The third workplace is one that has a computer-based cash register, which gives visual and auditory feedback to the cashier. This was specially designed and built to make it easier for people with intellectual disabilities. This was installed at a small café (W3).

6.3.4 Participants

The age of the participant workers was between 18-22 years old and the tutors were between 35 and 64 years of age.

All the workers that participated in this study have been diagnosed with development disabilities using the criteria of having an IQ under 70. IQ 70 is not a definition that makes it easy to understand their individual difficulties. The workers have different types of difficulties. It is much easier to describe the workers using Kylén's model of ability and by this receive a better understanding of the individual's difficulties. On one

hand the PASS model (Äystö, 1993) is more a description of the individuals' positive abilities. On the other hand, ICF (Socialstyrelsen, 2003)is a description of the individual in a broader sense incorporating the measure of quality of life. The tutors' description of the workers contained a mixed view of the descriptions above.

6.3.5 Methods

The study was conducted as a comparison among three cases in the different workplaces. There were three ways of collecting information in each workplace. Collecting information was made in two kinds of observation and one interview.

Two different observation types were made:

The first observation was done by the researcher on a daily basis, with manual registration (Pen & Paper), and

The second observation was a video recording including dialogues and only recording the subject's hands when handling merchandises or money.

The second observation was made in form of video recordings, where one of the workers made the recording. The instruction was to record only the participant's hands when handling merchandise or money. The sound was also recorded with the video recorder.

In the manually made observation there were four workers and one tutor in the workplace (W1). In the workplace W2 three workers and two tutors were present during the observation and at workplace W3 four workers and two tutors were present.

The recorded observation was made during one working day on each workplace. In the workplace W1 were four workers and there were two tutors. There were 3 workers and one tutor as a research person in workplace W2 and in workplace W3 were four workers and two tutors.

The interviews were made with eight workers (three males and five females) and four tutors (four females).

6.3.6 Analysis method

The interview and the video recorded observations were transcribed according to Linell's second level of transcriptions (Wibeck, 2000). This means that the transcription is performed word by word with all identifiable words transcribed and all pauses notated.

The manual observations were documented by taking short notes of the activity and describing the activity.

6.3.7 Result

Most errors occurred in the phases of calculating and giving back the change to the customer in both W1 and W2. The tutors have an assisting role in these workplaces.

“The most difficult part is to count how much the customer should pay and to calculate the change to give back, but the most difficult part is how much money to give back”, a worker in the study said.

During the observation we noticed that a large number of workers indirectly waited for some form of feedback from the tutor. It almost looks like the tutor is not aware that the worker waits for the feedback. In workplace W1 the workers help each other with the calculation and during the observation it seems that the customers more often give exactly the right amount of money to the cashier than in the other settings.

Both the tutor and the workers in workplace W2 had difficulties handling the ordinary cash register. There is some non-logical component in using the ordinary cash register. One is that they have to type in 23 00 to register 23 SEK. The obstacle is that they always have to put in the hundredth. Another thing that was very obvious was that some of the workers in workplace W2 (working with the ordinary cash register) are holding their index finger above the button that they intend to push and they are waiting for feedback from the tutor. The tutors provide feedback in these situations but they were probably not aware of it.

The workers in the workplace, where they use the special made cash register program (W3), were more in control of the situation. One of the tutors said

> *"We have a worker that cannot count but here in café he is functioning excellently. He dashes to the cash register when a customer is approaching but when he works at the shopping tray he will not even come close to handling the money."*

He is very accurate when he is in charge of the cash register and is using the pictorial support in the cash register very carefully.

One of the tutors had experience from working in shops before she begun at this working place. She told us during the interview that her own need of introduction to the cash register program in workplace W3 was very small. That depended on the program's intuitive user interface. She could not see any disadvantages in using this interface, due to the simplicity.

The workers with intellectual disabilities who are using the computer-based tool have gained more control and satisfaction over their work environment. The result of the present study concerning empowerment and the subjective feeling of control is in line with Granlund (Granlund, 1996). The staff felt that they did not need to supervise the whole time. The error per day in this case was less than for both the other cases. Interestingly, also the staff members felt that the system provided good visual and auditory feedback, and it was easier to use than the ordinary cash register.

Interestingly, also the staff members felt that the system providing visual and audio feedback was easier to use than the ordinary cash register.

One of the workers said with pride in his voice about the W3 workplace.

> *"Anyone cannot be a cashier, one must know how it functions."*

6.3.8 Discussion

Concerning the method deployed, there is one pertinent issue. The difficulty of interviewing people with intellectual disabilities is that there are larger risks of bias because they try to anticipate the "right" answer, i.e. they try to figure out what the researchers want them to answer (Blomberg, 2003).

Concerning the results, it seems that the workers with development disabilities in the study of W3 gain more self-confidence. This was something that made a difference when interacting with the customers. In W3 the individual's functioning was more equal than in W2 and W1, i.e. the difference in ability was less important. This difference is probably related to the amount of technological support in W3 and the lack of support in W1.

The difficulties the workers experience are not unique for people with intellectual difficulties. Most problems are common for both the workers and the tutors. Accessibility, usability, acceptability and engagement of the user can be used as quality measurement terms (Benyon, Turner, & Turner, 2004). In this case the question is for whom these specific terms benefit for W1, W2 and W3? In W1 and W2 the

accessibility is excluding many people with intellectual difficulties, but in W3 there is a lager non-excluded group. The same is probably true for usability and the engagement of the user, but in the acceptability part there can be a discussion if all people, with or without intellectual disability, can accept using a tool that was designed as an assisting tool for people with development disability. The clarity and simplicity of the interface are not signalling an adaptation tool, but are rather signalling an ordinary working tool. This is desirable in the vision of "design for all". Products that are "designed for all" are products made to be possible to use for a wide range of people (European_Commission, 2007).

The result of this study is in the same direction as the result of the HI project "Mentek" (Granlund, 1996). The workers with intellectual disabilities, who are using the computer based help ware, gained more control and satisfaction in their work environment.

Is it possible that a helping device, like the one in W3, is a tool that makes it easier even for people without defined disabilities? Is this kind of feedback something that is important to most people when interacting with technology like computers? Using different kinds of multi-modal feedback is not specific for people with disabilities. People with defined difficulties can probably indicate the simplest, working feedback in order to make artefacts easier to handle. Even the staff members felt that the system providing visual and audio feedback was easier to use than the ordinary cash register.

The workers with development disability indicated very accurate difficulties in the working environment. The tutors said the same but

that came up later during the interview in contrast to the workers' immediate response. This indicates that people with difficulties faster indicate areas of difficulty. (Ohlsson, Persson, & Östlin, 2005).

7 Conclusion

This chapter illustrates the research questions under the headings “design process”, “product and services”, and “other issues”. The final part of this chapter and thesis discusses further research opportunities from my discussions and conclusions.

7.1 The design process

The first question that is illustrated was in the area of the design process:

> *What impact on the design process has involvement of people with defined difficulties?*

In a Human Centred Design process the user is one of the main objectives. How do we describe a normal user in a normal environment? Are these questions relevant?

When I took a programming course a teacher told me to evaluate the program in the most extreme use it was intended for. Well, why not use the same approach when choosing participants in the design process.

In section 2.2 I have described the difficulties to find a normal or even representative user. In design we often try to design with a representative user group in mind. Could there be other way of choosing target user to have in focus? In the PTS project (section 5.1) and in chapter 6 both of the studies point out a possible direction of using people with development disability as indicators for finding problems in the usability area of understanding.

In the TED-model (section 5.2) it is suggested to have an indicator group, chosen so that the group includes users with defined difficulties. In most of my experiences the users, who participate in design processes, are users that have some form of interest in new technology. In Utopia (Bødker, Ehn, Sjögren, & Sundblad, 2000) the users that participated were mostly active trade union members, who had some form of interest for new technology.

One important thing to catch is what Engelbart calls the “Collective IQ” (Engelbart, 1962) and to bring it into the design process. In Utopia this was done by bringing together different kinds of workers as well as management and a group of researchers. This “collective IQ” was then used in workshops/activities to bring forth new ideas of working tools and methods. These workshops were a way of enhance the communication between the participants and in this way also boost the creativity in a practical way.

A more market driven approach the “Lead user”- concept (Hippel, 2005). The approach of Utopia was very closely, in my point of view, driven by “Lead users”, the collective of the graphical workers who had the work knowledge together with other experts become a collective of “lead users”, who iteratively realized new working technology and methodology.

The architect I.M. Pie states that “Spatial relationships need to be experienced” (Mace, Hardie, & Place, 1996). It is not simple to imagine other people’s perception in different situation and environments. To bring in people with difficulties in the design process is to bring in at least one more perspective. This is so to say contributing to the “Collective IQ” of the user centred process.

Is it possible to connect users with difficulties to the “Lead user” approach? In the examples of section 2.3.5 we can see a line between the needs of people with disabilities and products that are of value for all. In my experiences of working close to people with functional disorder I have often gotten solutions to problems of their needs from the user. But the user has not the ability to make it. One of the solutions I have

described in section 2.4 was a word predicting system. This solution came from the user but he did not have the knowledge to make it. The user was a man that was lame up to the neck and he was blowing and sucking to type on the computer. Is it possible to use this force of invention as an asset in design processes? I would like to call this “the Lead of Need”.

With “the Lead of Need” I mean individuals with functional difficulties, who have a need, an idea for a solution, but no possibility to make it happen. I think that many individuals with difficulties have a creativity that is built on that they perceive the small problems and see a solution but they can not realize it. Those who do not have these difficulties are so used to “go around” the problem that they don’t se it but when presented to the solution it is experienced as a good thing. The result of the studies in this thesis is pointing in this direction.

7.2 The product or services

The second research question was:

> *What are the impacts on the end product or services when involving people with defined difficulties in the design process?*

My starting point on the impact on product or services is by linking it to the questions of usability and accessibility.

I will just remind the reader that usability and accessibility is not the same but they are very close related. If the product or services is not accessible it doesn't matter how usable it is. On the other hand a product or services can be very accessible but is not usable the consequence is that it becomes very hard to get user to use.

But it is not that simple. Eftering has a point in his doctoral thesis (Eftring, 1999) from which I brought forth the term "usworthiness" where utility, usability and the users high prioritised needs is considered to be important for the users use of the product or services. This term was created in the context of people with physical disabilities. I think that this term is very relevant for all kind of users, even for different stakeholders. I also think that combining different user groups' highly prioritised needs is a challenge that designers and others that are doing development must find a good solution for.

How do we measure usability or accessibility? There are a lot of examples of how to measure usability and who is doing it. In my point of view the usability and the accessibility should not be measured from a normality perspective. The results of the studies in chapter 6, the PTS project (section 5.1), and the Swedish Rheumatic Associations test

methodology (section 5.3) is pointing out that both the usability and the accessibility are possible to measure from a human functioning perspective. If we set the usability and accessibility levels from a low human function level, then all with higher functioning should gain better usability and accessibility.

This could be a new way of describing quality of usability or accessibility for products and services.

My experiences, from the Web sites study (section 6.2) and from the Swedish Rheumatic Associations test methodology (if it is used in a design process) indicate that the products and services have better chances of becoming better in usability and accessibly perspective.

I think it is possible that this kind of “design for all” approach in the design process is a facilitator for a better quality for all users?

7.3 Other issues

The third and last question was:

> *What other issues will appear outside the design process as consequences of involvement of people with defined difficulties?*

Usually design approaches are from the opposite direction to "Design for all" even if we say that we have a "Design for all" approach. The question we think we start with is how we can make the technology accessible for as many as possible, but usually what we actually are doing is that we are starting from a group of normal people where the people that are excluded are going to be included if possible. I think this is a symptom of our way of trying to group people in us and them.

Even in this study it is very obvious that the participants refer to us and them. The older people in the study of section 6.2 refer to people that have more difficulties than they have themselves, when discussing the size of text. The same happened within the group of people with development disabilities but they were referring to others' problems in fewer cases. I think this is a generic problem that we have to take into account in research. Is the answer an answer to a vision or is it from their own experience?

The Swedish government has stated that in the year of 2010, Sweden should be accessible (SOU 1999/2000:79, 2000). Even in this document the starting point is to include. This implicates that the starting value is that we are excluding somebody. But why always use this as the starting point? In my thoughts we should turn it around to; what should we do to "exclude as few as possible" in a design process.

Is it possible that the approach in this thesis, which uses the ability of people with difficulties, will enhance procurement of public ICT solutions? A user centred process to gather the requirements with this approach should automatically include the accessibility issues.

If we take a step back, what will happen if this approach, using the ability to find difficult areas, is used more generically, for example if we are thinking of applying this on information material from the municipality. Would the information be accessible for a larger group of people?

In research could this approach for pre-testing be used to secure the quality of questionnaires, or other kind of contacts with research persons?

A couple of months after the studies of the web site studies (section 6.2) I gathered the participants in the indicator groups to present the outcome of their participation. I showed them the sites that they had been part of developing and described their comment and suggestions vs. the outcome. They realized that their thoughts of what was difficult and that their suggestions were important, not only to themselves but also to others. My reflection after this meeting is that if people with difficulties (which also is included in the group of consumers) are letting their voice be heard to the producers, then there is a possibility that we all can get more usable and accessible products. One good example of this is the Swedish Rheumatic Associations activity influencing producers to make “easy to open” packages.

7.4 Final conclusions

The accessibility and usability areas are easier to include in the design when having people with difficulties in the design process. But on the other hand do we really know that all users have a certain level of functioning? How do we know that we are not, by excluding some group, missing some innovation that could be good for everyone? In my view a "design for all" approach in design is a facilitator for good quality.

Design for all is more of an attitude than methodology in most people's eyes. If we use the ability of people with difficulties as a facilitator to get better design then it becomes more of an approach than an attitude. Then all people can gain something on this and not only people with disabilities. What I am trying to say is **not** to think of "design for all" as something only for people with disability, but for all people not excluding people with disabilities.

Is it possible to have a "design for all" approach without excluding someone? Is it "design for all" if we design in a way that people with glasses should be able to use the product or services or is it "design for all" to design it in a way that people that normally where glasses have to take them of to us it? There are a lot of people that have individual aids such as; a wheelchair, a walking crutch or a personal assistant that is helping to interpret the surroundings. Is it "design for all" to design for "all" in a democratic sense? To give the individuals the possibility to decide, on their own conditions, is very important for me.

To use this democratic force in innovations and design processes could be important for public as well as companies' further development.

People with difficulties can be a great source for new innovations, which I have named “the Lead of Need” in section 7.1. If we can organize a meeting ground for designers, developers and individuals with “the Lead of Need” we have created a “living lab” for new innovations.

If we bring in this kind of methods even earlier in the design process what would happen? Is it possible that in the ISO 13407 standards in the first steps of “understanding and specifying the context of use” and when “specifying the users’ requirements” the indicator group could contribute with a new dimension?

7.5 Future areas of research

There are several areas in this thesis that I specially point out as suggestion on further areas of research:

- This study has focused on using people with development disabilities as research persons. What happens if people with other kinds of difficulties are included in the design process?
- How can people's difficulties be described in a understandable way for all stakeholders in the design process?
- Are people with difficulties using ICT products and service in the same way as others?
- This study has only looked into a small part of the design process. What happens if it is used in the whole process from idea generation to ready product or services?
- In what way is a procurement of public ICT solutions enhanced by using this thinking?
- How can new measuring tools for usability and/or accessibility be made from how people function and not from statistic representatives from the group of users?
- In what way can this design approach be used for design outside the ICT field?

7.6 Finally

And finally let's return to the question of designing cars for blind driver! Well at a first look it would be obvious that this would be just crazy. But what is the car industry doing today? They are developing cars that are so smart that they can read signs at the side of the street. If an obstacle appears then it takes automatic action to avoid it. Before you start your journey you put in your destination. The car has an auto driver so you don't have to drive. Volvo already has a car that can automatically pocket park. Well, how far are we from designing cars for blind? Maybe we should have individuals that are blind in the group when we do co-operative design around a new car.

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