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Abstract

The power of periods of learning and the knowledge of training professionals are underestimated and unexplored. The challenges posed in this dissertation to usability and HCI deal with the transformation from usability to use quality, and learning as a means to promote use quality.

Today, the design of interactive artefacts is mostly based on the assumption that the best design is achieved by formatively fitting properties of the artefact in an iterative process to specified users, with specified tasks in a specified context. As a contrast to that one current trend is to put a lot more emphasis on designing the actual use of the artefact. The assumption is that the best design is achieved through a design process where the artefact is given form in accordance to how it is put to use.

We want to provide stakeholders of systems development with an increased sensitivity to what use quality is and how they might participate in focusing on use quality. Thus, we have asked ourselves what specific use qualities, and models thereof that we find and formulate when studying a set of systems in use at a bank, for the purpose of supporting learning environment designers.

This thesis reports on the development of a theory of use quality based on theoretical investigations and empirical research of use qualities of interactive artefacts. Empirical studies were performed in close collaboration and intervention with learning environment developers in two development projects, focusing on use qualities and qualities of learning to use the artefact. The four studies comprised; 1) (learning to) use a word processor, 2) using experiences from that to formulate models of use quality as a design base for a learning environment for a teller system, 3) (learning to) use the teller system, and finally 4) assessment and modelling of the use of the teller system.

The specific results are a set of models of use quality, encompassing a number of empirically derived use qualities. The most central of the latter are; *surprise and confusion*, the thin, but bendable, border between ready-to-hand and present-at-hand, an elasticity of breakdown; *ante-use*, that which precedes use; *dynamicity and activity*, the time-based qualities without which the interactive material can not be understood or designed. The general results are presented as a theory of use quality, represented through a set of models of use quality. These models are aimed at design for use, rather than focusing on, in a monocultural fashion, an artefact's properties, its usability, its presence or the user experience.

contents

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First of all I would like thank myself. For enduring. For lack of self-criticism. For writing it up. For leaving it behind.

Secondly, I would like to thank Ann for supporting me deciding to pursue this specific trajectory, among the others, back in 95, and for the unselfish loving support throughout the process; to the very end. After having finished discussing content and arguments, you never tired talking through it once again.

My two kids, Kerstin and Beata; I have finished writing the book. No, you don't want me to read it to you.

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I also wish to share two quotes from my guitar teachers that have followed me through the process; "*It's better do it slow and correct the Wrst time, when you learn the arpeggios. If you learn it fast and wrong it will always be almost wrong.*" (Mats Nermark). "*You should not be able to play this for several years. But, explore how to play it technically now, play it slowly and decide which fingers to use.*" (Tord Sandell).

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SECTION I – PREMONITION

who are you,little i

(five or six years old)
Peering from some high

window;at the gold

of november sunset

(and feeling:that if day
has to become night

this is a beautiful way)

52 in 73 poems by ee cummings

1.01 Framing the research

Interactive artefacts are valued by users and their businesses' for their qualities in use, while the development of systems rarely is managed or valued by the finished products qualities in use.

In today's businesses, employees use a wide range of software for or in their work, be it general applications, proprietary software or intranets. Some applications function as tools, some mediate, whilst some are an integral part of the business process; without them no value is added. Traditionally HCI takes on the task to foster the development of usable systems (see e.g. Ehn & Löwgren 1997). With some exceptions research within HCI, and the sub-area usability, has focused on the *development of systems*. The power of, e.g., periods of learning, the knowledge of training professionals and knowledge harboured in procurement processes, are underestimated and underexplored. The full implications in practice of this ignorance, viewed as a limitation, have not yet been uncovered. A practitioner's account of a few trends in relation to that will be given later (PAGE 18f). The challenges posed in this dissertation to HCI deal with the transformation from usability to use quality, and learning and learning developers as a means, or a vehicle, to foster, interpret and understand use quality.

The research presented in this dissertation tackles the challenges posed to usability through a hermenutic process comprising a theory development part and an

empirical investigative part. In the former I try to develop and structure theories regarding interactive artefacts' use qualities, through reading a wide range of literature, of which a selection has been included in the thesis.

In the latter I perform practice based empirical work in close collaboration and intervention with learning developers at a company. Through my active participation in two development projects over a period of four years, they were provided with tools to think with, and material regarding use qualities especially in ways that learning may promote use and use qualities of an interactive artefact. Participant observation, contextual interviews, questionnaires and practitioner workshops were used to collect empirical material. The practitioners, those involved in the development projects, and others participated as co-researchers. In an interpretive process we developed specific use qualities, some of which I hold for being more generally applicable than in the specific situations from which they emanated.

The aim of this research, as well as the thesis, is to theoretically ground and describe the understanding of use qualities gained cooperating with learning developers, as well as further theories of use quality. Within the first few chapters of this thesis we will seek a reasonable position for furthering the discussion.

Reframing usability

One of the central terms within HCI, usability, even though it has been honoured with quite a portfolio of ISO standards (e.g. ISO 13407, ISO TR 18529, ISO DIS 9241-11, ISO/IEC 14598-1), it has also been subject to major shifts in meaning throughout the years[1]. This alone would call for research on the definition of the term, which is one of the inspirational sources for this work. However, the research presented here develops another term, »use quality».

By doing that usability will be reframed, and thus implicitly, and sometimes explicitly, defined. While doing this the terms are polarized. For the sake of reading it is important to note that usability then will be

1. Compare e.g. Preece, Rogers & Sharp (2002) with Ehn & Löwgren (1997), or Whiteside & Wixon (1987) with Schuler & Namioka (1993), or Eason (1984) with Beyer & Holtzblatt (1998), or Nielsen (1993) with Dunne (1999).

used synonymously to usability engineering, user centred design, and other terms that rely heavily on the definition of usability[2]. This might feel unfamiliar, and as a narrow perspective; it deliberately has a defamiliarizing effect. Some patience is required from you, the wider and richer perspectives will be dealt with.

There are two reasons to construe a polarisation between usability and use quality. The first is for the sake of clarity and for carrying through the arguments; even though many aspects of use quality are included in definitions of usability or in HCI-practitioner's understanding and use of usability. The second is for the sake of how usability is interpreted outside the knowledgeable realm of HCI- practitioners, where it has a fairly narrow definition; e.g. of course usability influences aesthetics, but it is not an aesthetics in itself and mostly acts counterproductive to aesthetic thinking (a graphical design account), or that usability mainly influences the user interface (a system architect account), or that it is possible to require of a user interface designer to refrain from doing usability work during programming time (a project management account).

In this chapter the larger frame for the research will be treated in two parts. The first will foreground[3] use quality, and the second will look a little closer at the business of learning to use technology.

Foregrounding use qualities

Instead of focusing on the products as such, the concern should be »use qualities», in order to shift focus towards the *development of the use of artefacts*. Without going into any lengths as to what use quality is, which is an endeavour partly covered by this thesis, a brief note is appropriate here.

»Use qualities» are *what characterizes the use of an artefact*; in this thesis interactive work-oriented IT-artefacts.

Traditionally within human-computer interaction researchers are concerned with functionality and properties[4] of the product, such as its efficiency, its learnability, *et cetera*. (see e.g. Allwood 1991, Nielsen 1993).

2. It would be more proper to say that they rely on the possibility to rationalistically define usability, or that they rely on the activity of rationalistically defining usability. But, at this stage, this would complicate matters too much.

3. Foregrounding is here used in the Russian formalist sense, that a system of text is not a free interplay of equal elements but presupposes the foregrounding of one group of elements ("a dominant") and the deformation of others. (O'Toole & Shukman 1977, p 34).

4. A term which will be dealt with more thouroughly in CHAPTER 04. It refers here to the common understanding of the word.

On the other hand we have those interested mainly in the human part, such as cooperation, co-ordination and community (see e.g. Waern 1998, Rogers 2000). When it comes to use qualities it is neither a focus on the things nor on the humans; it is the act of focusing on the artefact-in-use.

Usability, the traditional concept of HCI, have several drawbacks, some of which are well-known (see e.g. Winograd & Flores 1986, Adler & Winograd 1992, Trauth & Cole 1992, Dahlbom & Mathiassen 1993, Grudin 1993, Landauer 1995, Löwgren 1995, Dunne 1999). As a complement to the current trend towards interaction design (see e.g. Winograd 1996, 1997, Ehn & Löwgren 1997, Löwgren & Stolterman 1998a, Dunne 1999), only a few drawbacks will be mentioned here.

Usability presumes that the single system is used by one uninterrupted user knowing her task, utilizing the system to fully or partially solve it in an as efficient and effective manner as possible.

Usability focuses on the features of the system, not on the behaviour of the user, nor on the interaction of the artefact with the user's formal and informal organisation. It is also hard to imagine a usability specification harbouring such aspects as how the notification system in a power plant should feel to the user, or how a game should spur discussions the day after the game was played.

Thus, usability runs into problems where IT has become an integral part of the business process. Several consecutive or simultaneous users, several simultaneous applications, as well as deliberately choosing an ineffective manner of solving the task, are all part of what usability can't handle. The goal for an application might be to become a »meeting place», which in itself is a use quality. It is not a usability factor, those are derived from such a statement; e.g., measuring the ease of connecting to the application, and the ease of finding out whether there is someone there one would like to meet. The use quality could inflict changes in how users do their work, how the organisation is set up, how the physical structure of a company is planned *et cetera*. Something which considerations based on usability theory cannot perform.

Usability also focuses on analysing artefacts as work oriented artefacts. Which means that learning or game artefacts also are analysed as if they were to be used in a work setting with tasks and external goals *et cetera*.

> *If I as a consumer and user read certain practical and functional qualities in the design of a casting rod, I also see them perhaps as a means of showing that I belong to a prestigious group of knowledgeable amateur anglers; or the design brings back old memories and the rod becomes something to look at and remember by; or the opposite: I associate the colour and finish with something I disliked or something that was of poor quality, experiences that may be difficult to ignore.*
>
> Monö, 1997, p 20

The practical and functional aspects are the stronghold of usability, but when it comes to the social, the aesthetic, the symbolic *et cetera*, usability is not sufficient. And when using products all those are of great importance. Thus, usability shows low performance when trying to deal with other applications than work-oriented artefacts.

Furthermore, usability is what could be said to be a static concept, due to its technology boundedness, and the communicative arena for usability is also fairly narrow, mainly focused on engineers, developers and other roles in activities in the construction/programming of the interactive artefact. Use quality, on the other hand, is dynamic in its definition and models, per se, and the communicative arena is wider spanning animation artists, designers, developers and several more participating in activities where the interactive artefact is characterized and designed (see FIGURE 1).

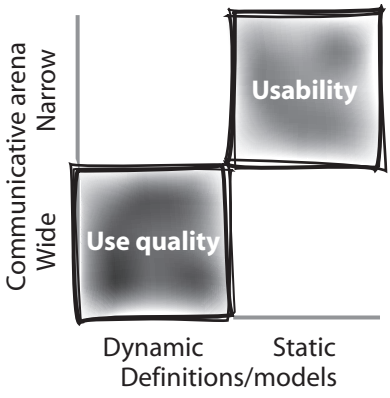


Figure 1. **The character of the communicative arena and definitions**

We should not discard the work done within usability, but be careful

about how we use it. We still need to base the design of interactive artefacts for use quality on theories of use quality and empirically based models of use quality. Such theories and models may be utilized formatively in design processes.

In order to meet these demands there is a need to develop concepts that focus on use of IT instead of on technology or its (re)presentations. That is, to explore and develop concepts of use quality.

The business of learning

Among other alternatives, such as purchasing systems, organising around technology, changing tasks and processes *et cetera*, *learning to use* an interactive IT-artefact seems to be especially interesting and urgent; certainly considering the way learning contributes to the effective and qualitative utilization of information technology, the growth of the learning market, and through that the growing importance of the field of learning. Learning holds possibilities; it contributes to making information technology more usable and fit for its purpose for individual users in their work and to organisations in their strive and business goals.

During the 1990's there have been a debate regarding the so called productivity paradox (see e.g. Strassmann 1990, Brynjolfsson 1993, Landauer 1995, Lundgren & Wiberg 2001). The conclusion of the debate is more unanimous than one might have expected in the beginning. A company's ability to use appropriate information technology[5] efficiently and effectively to reach their business goals, more often divides the losing companies from those who win. The premise for this is that investments are made in usable information technology that is useful. It is important to choose the appropriate product, hire the appropriate employees, have the appropriate competence, organize appropriately, *et cetera*.

> *The effective implementation of new technology, particularly computer-based systems, typically require more, not less worker skill and judgment.*
> Salzman 1992, p 66

5. The same goes for all kinds of technology. The classical example being the dynamo, (David 1990)

When Strassmann (1990) shows that the cost for training regarding a specific investment in information technology can be four times as large as the investment in software, Salzman might just not be so surprising.

What is not clear from Strassmann is what view the companies he has been researching have on the introduction of information technology. Clement (1994) paints two extremes

> *… the "optimistic" or utopian view, which sees computers as benign, even friendly devices under the control of workers, liberating them from toil while offering new possibilities for creative expression and social engagement; and the "pessimistic" or dystopian view, which sees computers as extensions of oppressive management imposed on workers, rendering many human skills redundant, and monitoring every move to enforce an unrelating pace of routinized production.*
>
> Clement 1994, p 55

Most of the time none of these pictures are realised, instead every case falls in between. Still, the introduction of computer support implies that some knowledge will be left behind; work routines change, skills knowledge deteriorate and disappear, values, decisions, opinions and judgements change owners (Dahlbom & Mathiassen 1993).

> *It is not only the artifact that has to evolve – the users have to change in order to make the most of the artifact.*
>
> Dahlbom and Mathiassen 1993, p 74

Many of the changes in technology within organisation that have characterized the 80's and 90's have carried with them changes that require new knowledge and competence from the employees. Brown and Dug-

uid (1992), e.g., state that the division between novices and experts no longer is fruitful

> *Novices are learners; experts have learned. This overly simple distinction fails to appreciate the way in which expertise is a fluid, social construction that is constantly subject to redefinition, the more so in times of rapid change. Learning is continually demanded. /…/*
> *In fact, the conditions of being a novice recur in different forms and do not disappear with increasing competence. Indeed, it is possible for people to be simultaneously novice and expert. /…/*
> *…at some time and in some way, anyone can be both a novice and an expert.*
>
> Brown and Duguid 1992, pp 172

The quicker the changes, and the more comprehensive they are, the more often an employee will need to learn again. Work tasks disappear through automation, through changes in work division, work tasks change, through information, they are new and disappear.

It is not reasonable to assume that employees can be turned over every couple of years, in order to open up for the change of knowledge base the organisation has. Instead employees need to re-learn. As an expression of this the term »empowerment» has been used. Instead of deskilling through automation, the technology should be used as a means to strengthen and develop the employee's possibilities to contribute to the growth and survival of the organisation.

> *… staff will no longer be regarded as mere "users" but as real "actors" with their own distinctive voices and constructive roles to play in the ongoing dramas of technological and organizational development.*
>
> Clement 1994, p 62

Brynjolfsson (1993) also points to a possible reason that information technology has not increased productivity as was expected

> *… if significant lags between cost and benefit may exist, then short-term results look poor but ultimately the pay-off will be proportionally larger. This would be the case if extensive learning by both individuals and organizations were needed to fully exploit IT as it is for most radically new technologies.*
>
> Brynjolfsson 1993, p 73

Taken together with Dahlbom and Mathiassen (1993), that the products, processes and content of a job changes with the introduction of information technology, it is reasonable to believe that Brynjolfsson is right when he speaks about the delaying effects of learning.

It might be that extensive learning is not needed, but that the learning is ineffective in itself, does not give the expected effects, is not given appropriate attention, is not assessed, or that there are several consecutive re-learning periods following from several technology shifts. The large cost Strassmann (1990) puts forward could be a result of what Brynjolfsson states.

Keen (1991) summarizes

> *the human element is the critical facilitator or bottleneck to effective use of IT, especially as the technology becomes more cost-effective… IT can quickly and almost completely erode the value of [people's] experience, create demands for totally unfamiliar skills, and stop careers dead.*
>
> Keen 1991, p 117

There is reason to study in which way learning could contribute to an effective way of utilizing information technology; especially considering the way learning contributes to the effective and qualitative utilization of information technology, the growth of the learning market, and through that the growing importance of the field of learning. Learning holds pos-

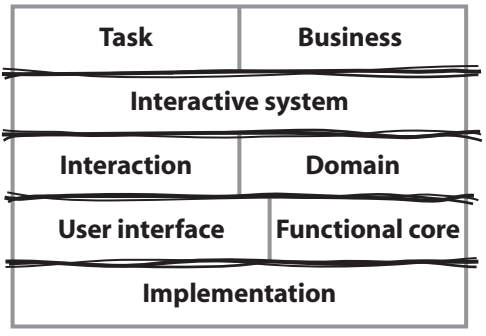
sibilities; it contributes with making information technology more usable and fit for its purpose for individual users in their work and to organisations in their strive and business goals.

Recapturing the structure of costs for IT investments gives a hint of the economical frames and possibilities. Brynjolfsson & Hitt (1998) says "… with each dollar a firm spends on enterprise resource planning software /…/ it typically spends $3-4 on consultants who implement the new system. Even bigger costs are incurred in employee retraining and time spent redesigning business processes." Training end-users has become vital when investing in information technology. More than four times the investment in software is spent on training users. According to Strassmann (1990), Landauer (1995) and Keen (1991), it is difficult to show that investments in information technology pay off, without looking at the use of IT.

Trends within HCI practice

Some implications, in HCI-practice, stemming from the limitation to the *development of systems* will be discussed shortly by looking at a few trends.

One trend is the isolation of HCI and usability activities to the interface, even though it is well known that, e.g., parts of a product's usability is determined through choices of technology, and that the choices of technology define and shape the possibilities and means for creating a usable system. In the radical end-point of this trend (with a conservative function) there is a tendency for usability and HCI to be aestheticized. Two of the driving factors for this are; the fairly recent shift of focus within HCI towards more subjective aspects (Löwgren 1995), and the layered system models used



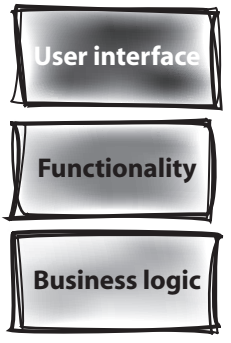


Figure 2. **Two generalized illustrations of existing layered systems models**

in system sdevelopment, (FIGURE 2) (see e.g. Balzert 1987, van Harmelen *et al* 1997, Nunes & Cunha, Nunes *et al* 1999). Given these two factors it is likely that many HCI-practitioners will find themselves trapped in activities concerning the presentation layer, at the worst doing cosmetic work. This will first be noticed in short project cycles, where management perception of usability and HCI-practitioner's subjective focus reinforce each other's rationales. (What has happened is that subjective/aesthetic values has come to the fore, in HCI education as well as in businesses). So, businesses hire usability professionals to do user interface work. And as long as management and the usability professional agree, maybe in silence, that aesthetics are important, user interface work will go on as usual. But, as soon as the usability professional wants to do something more profound, she risks running into a conflict with management on what she is supposed to be doing; especially if she's been doing a really good job for a while at the interface. So the penetration runs the risk of being shallow (Carlshamre & Rantzer 2000)

Another trend is the increasing amount of resources spent on usability activities in systems development projects. The priorities are clearly set; systems development is the central and most important activity. Other activities need to align themselves with the goals of systems development, and be included in the systems development process. As an example of subsuming to the locally bounded rationality of systems development, the Delta method (Carlshamre 1994a) chooses to introduce documentalists into the systems development process, instead of the systems developers into the documentation process[6]. Activities which do not meet these demands are still subordinate to systems development, in some cases through exclusion. For instance, training development, and even learning and training activities, are all regarded as side activities.

It is rather obvious that these two trends to a great extent are technology driven. HCI has taken on a technological guise which closes out the user, even though many singular activities are user based. Still, users are marginalized, and at top of the hierarchy sits systems development. It is

6. Beware the unnuanced use of the idea behind the Delta method. Look at Carlshamre's work (Carlshamre 1994b, Carlshamre & Tuminello 1995, Carlshamre & Rantzer 2000, Carlshamre 2001) for a detailed and critical view on the pros and cons of the Delta method.

precisely the theoretical division between human and computer in HCI models that generates this possibility, this unintended neglect.

On with use quality

There is a strong need for a concept which neither marginalizes users nor technology. In order to meet these demands there is a need to develop concepts that focus on the use of IT instead of on the technology or its (re)presentations. That is, to explore and develop useful concepts and models of use quality.

The aim of this research, as well as the thesis, is to theoretically ground and describe the understanding of use qualities gained cooperating with learning developers, as well as further theories of use quality.

The question you as a reader might pose at this point is what kinds of use qualities an interactive artefact should show to be good or fit. In the long run, and within the bounds of specific cases, this might be the central question. Ultimately this is the vision that we will try to shed light upon from different angles throughout this thesis.

A brief note on reading

The aim will be conceived in this dissertation by first formulating the research questions and the method of research. A theoretical and an empirical treatment of the research questions is followed by a discussion and the contributions of the research.

SECTION I is the introduction to the thesis. In 01 the larger frame and motivation for the research have been presented. In 02 the research questions are formulated and discussed. 03 treats methodological issues and gives an overview presentation of the research process.

SECTION II is the theoretical and philosophical foundation. In 04 the distinction between a properties oriented concept, such as the classical usability term, and a use oriented concept is charted out. In 05 existing theories of use quality are reviewed and the first attempts of modelling use quality of interactive artefacts are made.

SECTION III is the empirical foundation. In 06 the empirical process is detailed. In 07 use of a work-oriented IT-artefact is explored. In 08 the first empirical modelling is made. In 09 material is collected for the purpose of developing the models even more. In 10 there is more empirical modelling done.

In SECTION IV the research is interpreted and discussed. In 11 the results are presented, the analysis performed is interpreted and discussed, intertwined with an outlook for the future. In 12 the research as such is critiqued. In 13 the conclusions are drawn.

B [Marc Bernard] - Alla upptäckter sker av en slump
V [Boris Vian] - Alla upptäckter sker inte bara av en slump utan…
B - Det är ett missgrepp…!
V - Det är inte ett missgrepp, det är ögonblicket då betraktaren märker en anomali. Det är anomalin som får en att upptäcka… upptäckten, om man kan använda en sådan pleonasm… Det är historien om Flemings odling av Penicillum notatum …

from Boris Vian, radio transmission
in Patafysisk antologi by C. Hylinger

I.02

Inscribing the research problem

Given that there is reason to study both the concept of use quality and how learning contributes to a product's use quality, usability and usefulness, we need to formulate knowledge interests that will act as guides. This chapter will first provide a short recapture of an earlier research project, serving partly as background, partly as motivation. Secondly the two knowledge interests, what use quality is and how learning can foster use quality, will be discussed. Last, the research questions will be formulated.

Framing a paradox

The traditional concept of HCI, usability, carries with it problem complexes. Here an illustration will be given of that (see also Holmlid 1995).

In a longitudinal descriptive study of fourteen users (8 women, 6 men) learning to use Word (Holmlid 1995, Holmlid 1995a, Holmlid 1995b), the working hypothesis was that *subjectively perceived usability would not be influenced by a training program*. The training was performed by a professional end-user training company in Stockholm, one day a week, over a period of seven weeks. The users worked at a market-analysis company and were receiving training in using Word 6.0.

Measures, done with SUMI (Porteous & Kirakowski 1993), were taken before training, directly after training, and two weeks after training (5 men, 5 women). In addition to the questionnaire, semi-structured interviews were made two weeks after the training period, with all 14 course participants, to follow up on the SUMI scores (8 women, 6 men), even if they had not delivered a full set of three questionnaires. As far as the hypothesis goes, there was no significant difference in overall usability. The corroboration of the hypothesis is a signal towards the need for more studies of what training contributes to usability.

The general assumption within HCI is that usability increases when users learn to use a piece of software (Porteous & Kirakowski 1993, Kirakowski & Corbett 1990, Nielsen 1992, ISO 9241-11 1996, Bevan & MacLeod 1994).

The results from the survey in Holmlid (1995a) were that the quantitative data could not give more than partial support for the general assumption; that usability would change with training (SUMI factors Affect and Control increased). Furthermore the most reliable criterion (SUMI factor Overall usability) did not give any support to that expectation. Interestingly, though, the qualitative data seemed to tell another story. In the qualitative data users expressed that the usability of the software product had increased through training. Even so when the SUMI measures for that specific person showed the contrary; that subjectively perceived usability had dropped.

In the study the more experienced users increased their SUMI score, while the less experienced users decreased their score after training. In relation to the general assumption there is no simple interpretation of the results. Especially concerning the less experienced users; we cannot conclude that they did not learn anything, despite that they have so much more to gain through training. The interviews gave further clues as to what was going on. The less experienced users said that after training Word had become more usable to them, as well as more useful. This corroborate the general assumption, and falsified the earlier working hypothesis.

Thus, the sequence of decreasing SUMI scores catches something else, or more, than how subjectively perceived usability changes with training. One suggestion is that before training the less experienced users' perception of usability was probably based more on other's accounts of the usability of Word, or its usefulness, through internal marketing; the SUMI score after training is based more on their own experiences.

Several other interesting observations realted to training, three of which will be presented here.

The agreement on subjectively perceived usability showed an interesting dynamic. Before training the agreement was higher than two weeks after the training, but directly after training the agreement was higher than before training. It is important not to underestimate the power of learning periods, but the effects on usability must be measured at the appropriate time. Moreover, with SUMI it is expected that a broad user group agrees less than this specific group did before training; but that it should become an effect two weeks after training was somewhat surprising.

In the training setting users have less opportunity to perceive the helpfulness and learnability of a piece of software, due to the high availability of skilled support and colleagues. This influences the SUMI scores on those factors.

First impression is influential. Users scoring high before training, continues scoring high after training, and vice versa. The importance of setting a stage for first impressions are thus highlighted.

The main conclusions were that training influences usability, and that usability could serve as one evaluator of training outcomes, and most importantly that there is need for "*…reconsideration of the theories that are the groundwork of usability.*" (Holmlid 1995a, p 74). That is, shifting the focus of HCI and interaction design away from oversimplified and static concepts such as usability towards the richer and more dynamic »use quality».

In the follow-up (Holmlid 1995b) some in-depth analysis were performed with focus on the quantitative data, but no really thorough analysis was made of the qualitative data. The main contributions were that; usability has potential as one instrument to indicate if transfer of training has occurred; subjectively perceived usability is affected by users' self-conception; subjectively perceived usability can be used to assess whether the task/learning loop (Busch 1994) has been entered.

Research foci

The paradox – subjective usability scores decrease while users state the contrary – inspired starting out on this research trip. It motivated the search for alternative concepts to usability as well as alternative partners to system developers in interpretation of those concepts.

This dissertation comprises two research foci, expressed here as knowledge interests, leading towards the formulation of initial research questions. The first deals with the overarching question what use quality is, and the other with asking how learning can foster use quality.

What is use quality?

There is a strong need for a concept which neither marginalize users nor technology. One such could be »use qualities», a wider concept ranging from the artefact over the user, her activities and work tasks, to learning and work situations.

As a research focus use quality has received little attention, thus it is not clear *what theories and models there are, or what their basis are*. Few treatments of the theoretical foundations of use quality have been performed, although some analytic work has been published (Ehn 1995, Ehn & Löwgren 1997, Löwgren & Stolterman 1998a, Arvola & Holmlid 2001, Holmlid, Arvola & Ampler 2000). However, new models, or accounts that might be interpreted as such, for use quality are invented, consciously or not, by the day. Use qualities have this far mostly been studied

in terms of technology for the purpose of designing systems, or in terms of information systems for the purpose of organisational development.

HCI has a strong empirical basis and deals mostly with different kinds of models; of humans, of systems *et cetera*. Informatics on the other hand is mainly oriented towards factors concerning the deployment/introduction of systems into organisations, and mainly with a level of interest corresponding to organisational or managerial matters. Between these there is room for empirical work closer to the use of artefacts, empirical work which is up-close but still at a general level. And there is a need to invite new competencies to the formulation of what is of interest when talking about the use of systems.

There is a large need for more general research concerning use qualities as well as research focusing on activities other than the development of systems. The lack of empirical work, and especially non-macro empirical work, and the lack of involvement of, e.g. teachers, is notable. *What teachers can contribute to the understanding of use quality* remains largely unexplored.

If one by use quality mean how designers come to form and interpret use and how this is communicated between designers (Ehn & Löwgren 1997), between designer and user, *et cetera*, the relevant point of study would be design rationale, design communication, documentation *et cetera*. This would be to study the mediation performed by designers, and not use or use qualities as such.

Given this, I wish to start out with the more direct experiences of use quality. Thus, we focus on use as the unit of study, and we will do this in a learning context, where users learn to use a product through a training program designed by teachers, with whom we are cooperating for interpretation and understanding in this research project. We turn our attention to *what specific use qualities are identified through use studies performed around a period of learning*.

This is also the main research question. Other questions might be appended to that, formatively in the hermeneutic research process.

CONTRIBUTIONS. We intend to explore what the concept use quality means and how one might use it in a design process. We intend to refine and extend the concept. We intend to formulate models of use quality or aspects of use quality that could serve as communicative means in a design process. We intend to provide drafts for the development of theories of use quality.

How can use quality be fostered by learning?

It is quite obvious that use qualities can be influenced by many means other than systems development, and that designing for use qualitites might span more than just the artefact. Use qualities might be influenced by, and also be influential on, one might speculate, marketing, organizational change, socializing, *et cetera*. Each can be used as analytic perspectives on a data material, but more fruitful as frameworks to structure a whole research process. In this thesis none of these will be in focus, but might show through when the theoretical and empirical material is analysed and structured. Being less speculative, several other activities are closely interlinked with use quality, such as user support (Trauth & Cole 1992, Sein *et al* 1987, Craig 1992, Broadwell 1993, McIntosh, Page & Hall 1993) and job design (Clement 1994).

In many cases, an interactive artefact is never used unless users are *trained* to use it, thus the intended use qualities never show (see e.g. Nath 1989). As a matter of fact, in practice, most introductions of pieces of software at work are followed by some kind of learning period (see e.g. Keen 1991, Strassmann 1990), often in the form of a course. As of today we know very little about *what role learning to use a product plays in forming the use qualities of that product*, especially given that use quality is a multifaceted concept.

In such cases, it is always tempting to ask questions about the effect of an approach on learning outcomes, or *how learning influences a concept such as use qualities*, measured through consecutive evaluations. Trying to do this introduces a set of challenges regarding evaluation. According to

Kirkpatrick (1959a, 1959b, 1960a, 1960b, 1994, 1996) learning might be evaluated on four levels. As discussed by, e.g., Busch (1993), Carroll & Rosson (1995), Sackett & Mullen (1993), Krein & Weldon (1994), McIntosh, Page & Hall (1993), Doll, Xia & Torkzadeh 1994, Olfman & Bostrom (1991), Goodhue & Thompson (1995), Shelton & Alliger (1993) and Newstrom (1987), evaluating learning outcomes experimentally is not a straightforward task, partly due to the many variables that need to be controlled. Introducing use quality as yet another concept as an evaluator or indicator of learning seems not to be what is needed, and carries with it all the problems of evaluation. Expressing training outcomes as use qualities would not further our understanding of the use quality concept, and would not give insights into how learning might foster use quality.

In the literature quite a few factors have been introduced. A small (sic!) selection of publications regarding this is; Allwood & Kalén (1993), Bostrom, Olfman & Sein (1990), Busch (1993), Busch (1994), Gist, Rosen & Schwoerer (1988), Harrison & Rainer (1992), Jones & Biers (1992), Olfman, Bostrom & Sein (1991), Martocchio (1994), Martocchio & Webster (1992), Olfman & Bostrom (1991), Webster & Martocchio (1992), Adams, Nelson & Todd (1992), Scott (1995), Nelson & Cheney (1987), Sein, Bostrom & Olfman (1987).

This multiplicity is especially salient when looking at information technology, even more so when dealing with training at workplaces, that not only brings with it a period of learning but also a set of other interrelated changes; all of which makes it hard to point to what part, or how much, of an effect should be contributed to the learning period.

In such a setting an alternative is to work with the *potentials of activities of learning* as a way of investigating what role learning to use a product plays in forming the use qualities of that product. This could be done, e.g. by studying goal formulation and achievements for different learning activities, by studying what learning developers and managers believe is the potential of learning activities within their organisation as well as the reasons given for this belief in relationship to other activities of change.

In user oriented systems development, learning and training has also received little focus[1], even though the factor learnability has been a central issue (see e.g. Butler 1996). Some major work has been done (see e.g. Carroll 1998, Carroll 1990, Thomas 1996 for overviews of the area), most of which concerns measures of learnability and learning eects, or aspects thereof, methods and processes of learning, or user/learner modelling (Holmlid 1998, Mack, Lewis & Carroll 1983, Bösser 1987, Thomas 1996, Singley & Andersson 1985, Rosson 1984, Andersson 1982). The efforts are neither in accordance to the possible impact of learning and training nor its relative weight in costs[2]. It might just be circumstantial that learner-centered design has primarily not turned their interest to learning to use interactive artefacts, but learning other subjects through using interactive artefacts (see e.g. Soloway, Guzdial & Hay 1994). *What is special about the use of a learning environment for a system, as opposed to using the system as such, when trying to understand use qualities*, would be of interest to learning environment developers. They would also be interested in what a use quality focus contributes to their understanding of learning environments.

In order to get a rich picture of what models of use quality consist of and how they are structured, we collaborate with learning environment developers throughout the research process and especially when the modelling and synthesis is performed. This gives another perspective than that of the producers, certainly so because the learning environment developers in this case work at the procuring company. While working with teachers and learners we get the opportunity to understand what use quality means to them and how they interpret, use and understand such a concept. They will contribute with their understandning of use qualities, their experience from the business of the company and their structures and models of use quality.

CONTRIBUTIONS. We intend to construct models of use quality in close collaboration with learning environment developers. We intend to assess the content of models of use quality together with learning envi-

1. Learning and training have instead been a huge issue within the documentation and technical communication field (see e.g. Carroll 1990, Carroll 1998, Holmberg 1994).
2. Moreover, the studies concerning learning in the context of using interactive artefacts have been heavily skewed towards text editing applications (see e.g. Kay & Thomas 1995, Thomas 1996)

ronment developers as well as other parties concerned, such as system developers.

Main research questions

Before turning to methodological issues the research questions will be presented in a more condensed format. The aim of this research, as well as the thesis, is to theoretically ground and describe the understanding of use qualities gained cooperating with learning developers, as well as further theories of use quality.

- what specific use qualities are identified through use studies performed around a period of learning?
- what use quality models consists of, and how are they structured when modelling and synthesis is performed by and in collaboration with learning environment developers?

Eftersom epifenomenet ofta är en tillfällighet, kommer patafysiken framförallt att vara vetenskapen om det enskilda, oaktat den allmänna uppfattningen att all vetenskap handlar om det generella. /…/ eller mindre anspråksfullt /…/ lagar som man har trott sig upptäcka i det traditionella universum också är korrelationer mellan undantag, om än oftare förekommande sådana, men i alla händelser tillfälliga fakta, som reducerats till föga exceptionella undantag och därför inte ens har det säregnas lockelse.

from Alfred Jarry, definition
in Patafysisk antologi by C. Hylinger

1.03

Methodological considerations

This thesis comprises two research foci, what use quality is, and how learning may foster use quality. Two research questions express the initial understanding of the hermeneutic process.

In this chapter methodological considerations as well as an overview of the research process will be presented. First, my point of departure regarding methodological issues will be described. Next, there will be a discussion of methods, consisting of eleven themes. Finally, the chapter concludes with an overview of the knowledge generating process of the research described in this thesis.

My vantage point

At the most general level this work is a hermeneutic approach with a layer of critical theory. It is empirically close to people, as opposed to organizations or technology, and focuses on assessment and understanding.

It would not be possible to say anything about use or use qualities without being where the software is used at the time it is being used. This will be achieved by staying empirically close to users learning to use a piece of software in order to understand what that might bring in terms of understanding of use qualities, partly as a

researcher but also what practitioners (teachers as well as developers) contribute to that understanding.

At the micro level, I view this work as a dialectic effort where there is a constant alternation between problem understanding and considering alternative solutions (Rosell 1990, Löwgren & Stolterman 1998), convergence and divergence (Löwgren & Stolterman 1998, Jones 1992), vision and operational image and design situation (Löwgren & Stolterman 1998, Rittel 1984, Darke 1979), approximate solutions and big ideas (Rowe 1987, Lundequist 1995, Archer 1979), draft and specification, overview and detail. In this sense it is very much alike a design process.

During these dialectic processes the different ways of assessing and describing parts and the whole vary and evolve, as does my pre-understanding. Altogether these processes form an hermeneutic approach, where understanding of the issue at hand evolves through an alteration between "*(empirical laden) theory and (theory laden) empirical material*" (Alvesson & Sköldberg 1994). Such an approach needs a framework for critique, in this case a limited critical theory frame, related mostly to the emancipatory knowledge interest (for main sources see e.g. Habermas 1972, 1973, 1984). Hermeneutic research runs the risk of reflecting the experiences of the researcher or the institutions of which s/he is a part of. General critical assessment therefore will be made to review whether I reproduce or reinforce parts of the critical claims. This will reveal some of the contradictions of my arguments in a dialogue with the predominant understanding. (Lyotard 1984)

The aim of this research, as well as the thesis, is to theoretically ground and describe the understanding of use qualities gained cooperating with learning developers, as well as further theories of use quality.

Discussion of method

The main concern of this work is use qualities. Without going into any lengths as to what use qualities are a brief note is appropriate here.

Use qualities are what characterizes the use of an artefact; in this specific case interactive IT-artefacts at work. Traditionally within human-computer interaction, researchers are concerned with properties of the product, such as its efficiency, its learnability, *et cetera*. (see e.g. Nielsen 1992). On the other hand we have those interested mainly in the human part, such as cooperation, situated action, as well as community (see e.g. Waern 1998, Rogers 2000). Studying use qualities is neither focusing on the things nor on the humans. Methodologically these three differ in several important aspects, even though they might share specific tools, instruments, techniques and methods.

First and foremost it is a question of stance. Taking the property stance posits the research within a more objectivistic, rationalistic tradition; resembling psychology, natural sciences or engineering. Taking the people stance posits the research within a more subjectivistic, relativistic tradition; resembling anthropology, sociology or psychology. What it means, methodologically, to take the use stance within this work is the subject of this chapter, and of SECTION II. I will try to point out a few methodological critical considerations as well as some of the major methodological corner stones for the study of use qualities.

Unit of study

Given that the research is about use quality, the main unit of study will be the use of interactive artefacts. This means that, even though notes during field studies might be of a person character or an artefact character, none of these are the perspective which is under scrutiny. Instead of solely looking at keystrokes or mapping interface actions in a word processing application, the specific task of word processing at hand, say contract writing, will be in focus. Instead of looking at human responses in problematic situations, I will focus on the surrounding use, and when appropriate problem solving as a specific use. In fact, this means that everything that is part of the use will be included, i.e. not only the interactive artefact and the user, but also other artefacts and other persons. The use of the interactive artefact is merely providing structure, and a point

around which other things are, more or less, organized. Wood (1997) distinguish between object and process knowledge, process knowledge being "*…the knowledge required to accomplish the intended work* ***using*** *relevant concepts and objects.*" (Wood 1997, p 51, bolded in original text). Unlike Wood, thus, we start out with the use, and try to second everything else.

In the strive for understanding use qualities with theoretical as well as practitioner power, a long and trustful relationship, partly achieved through active participation from both parties, will be built with a project group as well as the informants.

This will allow for following small sets of individuals as they, their tools and their use changes, thus creating variation in the material as well as a foundation on which it will be possible to interpret, maybe understand, and discuss the sources of variation. Following individuals will provide the learning environment developers with material regarding how an individual is doing, rather than a comparison of samples of a population. As opposed to performing a broader study taking a snapshot of a diverse population, following individuals give educators a possibility to participate in the interpretation and relate to their own practice. Broader studies serve their purpose when models proposed need to be tried for their validity and applicability within reasonable limits.

In order to generate and understand use quality, given its immaturity, it is necessary to engage in the empirical material as a researcher. Secondary empirical material might be used later in the process of concept formation, or as a way of assessing the findings from the primary empirical material.

And, as might have been noticed, the term use quality is already used as if it was almost generally known what the term denotes and connotes.

> *Our questioning of the meaning of Being must begin within the horizon of a vague, average understanding of Being; for we cannot ask What is Being? without making use of the very term at issue. There is, accord-*

ingly, no neutral standpoint from which we might begin our questioning.

Mulhall 1996, p 13

Theory and model generation

All facts are coloured by theory. This is a theme from early 19th century Hegel, into the 20th century with, e.g., Heidegger, Hanson and Popper (see e.g. Hanson 1958).

Not only that, but several theoretical perspectives exist in parallel with each other. Such a rationalistic pluralism provides the possibility to assess and criticize, as well as cross-fertilization (Alvesson & Sköldberg 1994, p 55). In the research performed here several aspects of this pluralism will be evident. First, use quality is a multi-perspective concept, which will be dealt with in SECTION II. Second, with the active participation of the practitioners as co-researchers, different rationales will be introduced in the generation of theory and models, analysis and assessment. Still, the theories and models developed will always be my interpretations, being the one writing them up.

The models developed during the course of research will act as communicative tools, or as theory nexus (Carroll & Kellogg 1989, Gaver & Martin 2000). As such they will be developed, discarded, re-discovered, advanced, simplified, elaborated and abstracted. They will linger, but above all be finished.

On the part of the full-time researcher, inspiration was sought among the many powerful analytic techniques for theory generation among rigorous methods such as Grounded Theory (Glaser & Strauss 1967, Glaser 1978, Strauss 1987). However, while assessing and generating theories in close and initiated collaboration with practitioners, these would be too cumbersome and put limitations on which practitioners would have the possibility to contribute, i.e. only those that had been trained in performing coding activities. A larger flexibility than that is needed in the research performed. So, with regard to the ethnographic and intervention character of the research such rigorous methods were not used fully.

This research, in Heideggerian langauge, explores the "*a priori conditions for the possibility of such scientific theorizing*" (Mulhall 1996, p 4), i.e. the conditions and limitations for the property perspective of HCI/usability to be an appropriate theoretical construct. This will reveal the ontological presuppositions of that ontic enquiry. The study undertaken explores HCI/usability's relationship to the subject/object dichotomization, and through a questioning of HCI/usability's conception of subject/object proposes to focus on use and use qualities instead (Mulhall 1996, p 4f). This is similar to what Toulmin proposes; to question oneself when a given rule is applicable, instead of asking whether it is true or false (Alvesson & Sköldberg 1994, p 30).

Heidegger and Ricœur refers to truth as asking questions about what something means (truth as significative), as opposed to asking what it refers to (correspondence between data and results), or how it is used (pragmatic sense of truth) (Alvesson & Sköldberg 1994). For the development of theory the classical approaches within HCI do not carry far; most of them stand firmly in a theoretical position, or presume an, eclectic theory background, supposedly well known to the field. For the research performed here the significative sense and the pragmatic sense will mainly be utilized. To put it in Lewis, Mateas, Palmiter & Lynchs (1996) words; the models produced should provide a frame for understanding the research questions, and answers given to them.

Objective

Most standard approaches within HCI, Informatics or Cognitive Science would call for some kind of rigorous method, probably generating either a method, guidelines or a model of some kind. Choosing any of these would carry with it the risk of reproducing what is already known or to reinforce some of the paradoxes and contribute to their institutionalization without constructively expanding the scope or providing an alternative. Models produced within the disciplines stated most often are based on cognitive aspects of users or on organisational matters. As will be seen later none of these are wide enough to span use qualities, and they have

a strong quantitative feel about them, some even as Grand Theories; they strive for generalizations with large numbers of users participating, not really getting to know the specifics of the actual use; what is going on beyond the macro level. At most, they get to know what the users say has been going on.

Landauer (1997) points out four goals for HCI research; relative evaluation of systems or features, determining what a system should do, discovering relevant scientific principles and testing models, and establishing explicit standards or guidelines for design. Experiences from method/model development projects (see e.g. Carlshamre, Löwgren & Rantzer 1994, Carlshamre 1994b) points out the effectiveness of method development in intervention oriented projects, but also points out that methods and models need to consist of smaller sized tools, to be used in a portfolio of tools and approaches.

Developing an understanding for a new concept, such as use quality, comes closer to method/model development than it does the goals suggested by Landauer, mainly because Landauer presupposes a fairly cognitive view. Still, testing models bears some resemblance, in the sense that a concept, and theories on use quality, will be expressed and communicated *as models*.

Given the rationalistic pluralism of use quality, we are faced with two alternatives when we create models; either choosing different ways of studying use for the different perspectives, or using a method which provides us with a rich material spanning a wide spectrum. Another immanent aspect is the changes which occur in use, and how the study of use either should try to single out invariants or accept variation, to inflict changes or to seek control.

Landauer (1997) describes models: "*The idea is to build a mathematical theory that can generate data like those observed.*" Due to the nature of design problems, i.e. wicked problems, no such mathematical models can be constructed. Models in this case is rather a way of structuring a designer's experience, making sense of those experiences and making them communicable *across disciplines* and particular users use experi-

ences, and thus giving a sense of what must be considered and forming the structure and interpretation of the repertoire of exemplars.

Kind of study

When we are trying to create an understanding of a concept a qualitative approach is most appropriate. Banister *et al* (1994, p 3) characterizes qualitative research as "*(a) an attempt to capture the sense that lies within, and that structures what we say about what we do; (b) an exploration, elaboration and systematization of the significance of an identified phenomenon; (c) the illuminative representation of the meaning of a delimited issue or problem.*" When trying to understand a new concept and develop models and theories this is definitely the case.

A common misinterpretation of qualitative research traditions are that they do not deal with quantitative issues. Nevertheless, some are more prone not to allow quantitative issues. This is unfortunate, because qualitative and quantitative style, used appropriately, may cross-fertilize each other in data collection as well as analytical phases of research. Together, and used for their appropriate purposes, they provide a richer picture than any one of them could in isolation.

> *We believe that each form of data is useful for both verification and generation of theory, whatever the primacy of emphasis. Primacy depends only on the circumstances of research, on the interest and training of the researcher, and on the kinds of material [needed for] theory /…/ In many instances, both forms of data are necessary.*
>
> Glaser & Strauss 1967, pp 17f

In this particular case, where we are trying to develop an understanding of a concept and formulate draft theories, we are not as interested in how many of a population has property X or prefers Y to Z, as we are of their

descriptions of X, Y and Z in context of their work and in relationship to each other.

> *Qualitative researchers tend to lay considerable emphasis on situational and often structural contexts, in contrast to many quantitative researchers, whose work is multivariate but often weak on context.*
>
> Glaser, 1987, p 2

Until we have developed a better understanding of the concept, quantitative research will be used as a complementary perspective or as pointers into, or ways to probe, the qualitative material.

Context of study

The research has been performed in a real life setting, with a bank as primary home. Just as Wood (1997) suggests we will try to perform all collection of experiences and interpretations in the work settings of the informants. By actively participating in two development projects over a period of four years, a multitude of persons and organizations have been involved: several branches and individuals working at the branches of the bank; two system/training development companies, as well as the bank's internal system developers; some learning environment developers at the bank; as well as numerous other people, such as managers, colleagues to the persons involved, *et cetera*. Some of these acted as co-researchers.

There has been a growing interest in computer based training during the late 90's, and it has gained popularity during the course of the research. Choosing to focus on teacher based training would have provide the research project with a more direct access to the learning processes as well as the persons with the pedagogic/didactic knowledge and experience. Also, the learning environment developers are themselves responsible for the development of the individuals, follows them through their development, and most important can reflect directly on those experiences in relation to a use quality concept. With an interactive training material those being able to reflect upon the learning process are fur-

ther away from that process, and the learning material. This is also the basis for arguing that we first need to know something about classic training and live learning environments before we do all the neat interactive stuff.

Degree of involvement and intervention

The degree of involvement is not equally distributed over participants. Some act as informants, some act as co-researchers. When it comes to intervention, some will not be able to distinguish between the intervention and their everyday activities, while some will be aware of the intervention and taking part in it. Expressed in Reinharz (1992) terminology, *action research* as well as *collaborative research* is performed. Still, research has not been performed under a strict schooling of action research. Rather it is influenced by action research paradigms, as well as ethnography.

> *In general then, ethnography is concerned with understanding other people's behaviour in the context in which it occurs and from the point-of-view of the people studied.*
>
> Blomberg, Giacomi, Mosher & Swenton-Wall, 1993, pp 128f

As in the MUST method it is important to combine the ethnographic techniques with intervention (Kensing 1998). Through an intervention it is possible to form an understanding of the usefulness and appropriateness of the use quality concept and build upon the practitioners knowledge and assessment.

> *Being and Time shifts the focus of the epistemological tradition away from this conception of the human being as an unmoving point of view upon the world. Heidegger's protagonists are actors rather than spectators, and his narratives suggest that exclusive reliance upon the image of*

> *the spectator has seriously distorted philosophers' characterizations of human existence in the world.*
>
> Mulhall 1996, p 39

Not surprisingly Baskerville (1999) identifies three unavoidable effects of doing action research, all of which can be recognized in the research performed here.

> *Three unavoidable effects are the adoption of an interpretivist viewpoint of research enquiry, the adoption of an idiographic viewpoint of research enquiry, and the acceptance of qualitative data and analyses.*
>
> Baskerville 1999, p 4

Landauer (1997) presses on the importance of testing tasks and goals, and mixes thereof, that "*real individuals, organizations and communities will use it for.*" Within the scope of this research informants at the branches have been performing business as usual, learning environments developers have been engaged in development projects. As co-researchers the practitioners have assessed and analysed empirical material as well as theories developed within the scope of the development project as well as within a wider project of understanding what use quality is and how it might be interpreted and used within their practices.

Triangulation

Triangulation is the use of two or more methods of data collection in the study of some phenomena. Following Cohen & Manion (1994) and Banister *et al* (1994) we identify seven kinds of triangulation; data, time, space, combined levels, theoretical, investigator and method triangulation. Using several methods of triangulation facilitates richer and more valid interpretations.

For the research purposes stated here some triangulation is appropriate, given that what we want to study could be complex and is not well researched. While developing the concept of use quality references to

usability will be made, which accounts for some theoretical triangulation. Where appropriate qualitative data, collected through participant observation and contextual interviews, will be complemented with questionnaire data, which accounts for data triangulation, and in some sense for between-methods triangulation[1]. In the process of developing the concept of use quality, several researchers and practitioners will participate in the interpretation of the data material as well as in the modelling of the concept, thus accounting for investigator triangulation.

Transferability *et al*

In a research project which is mainly qualitative, focused on concept development, and utilizing intervention strategies, within HCI, the most common evaluative criterion is the *transferability* (Alvesson & Sköldberg 1994). Transferability is the equivalent to external validity for experimental research; to what populations or settings can the demonstrated effects be generalized. Transferability thus refers to the degree to which the knowledge produced, i.e. the results and the discussion, can be brought to have bearing in other settings than the one under which the research has been performed. Specifically, evaluating transferability requires a discussion on the limits across which it is doubtable to push the direct usage of the results.

In addition to this, in qualitative research, it is commonplace to briefly discuss what is sometimes called the methodological horrors, *indexicality*, *inconcludability* and *reflexivity* (Banister, Burman, Parker, Taylor & Tindall 1994).

INDEXICALITY. The problem of indexicality occurs when an explanation always is tied to a particular occasion or use and will change as the occasion changes.

INCONCLUDABILITY. The problem of inconcludability occurs when an account always can be supplemented further and will continually mutate as more is added to it.

1. As opposed to within-methods triangulation, which aims at demonstrating replicability, where between-methods triangulation aims at demonstrating validity (Cohen & Manion 1994)

REFLEXIVITY. The problem of reflexivity occurs when the way we characterize a phenomenon will change the way it operates for us, and that in turn will change our perception of it.

Critique

Combining a hermenutic approach with a critical theory reflection prevents both the hermeneutic circle to become merely a reflection of the researcher or her institutions (Alvesson & Sköldberg 1994), and the critical theory to be speculations devoid of empirical grounds (Bourdieu, Chambordeon & Passeron 1968).

Speaking with Habermas (1972), a critique would be an expression of the emancipatory knowledge interest. Not primarily in its societal and political sense, but as a way of investigating the interests and institutions of the research performed. Thus, the critical claim which I am carrying through will be posed as a critical question, as a kind of self reflection (Alvesson & Sköldberg 1994). It would be a way of uncovering the things that make the explanations given by me possible (Wrathall & Kelly, 1996, para 30).

The role of such a critique, an introspective passage, is fairly well illustrated by Blanchot, even though he speaks of literature, a work of art. He seriously questions the role of the discourse of critics as a discourse separate from that which is criticized.

> *However, literature continues to be the object of critique, although the critique does not give expression of literature. It is not a way for literature but for universities and journalism to justify themselves…*
>
> Blanchot, 1963, p33, my transl.

He continues a little later;

> *Critique is no longer a judgment from the outside, which brings out the work of literature and judges its value afterwards. It has become inseparable from the inner world of the work, it is part of the movement*

> *through which the work comes to itself, it is its own searching and the experience of its possibilities.*
>
> Blanchot, 1963, p38, my transl.

This all amounts to using critique as a self critical tool, enclosing it in the work, not only as a reflection over a process and its limitations, but as a critical examination of presuppositions, or critical claims, of the research.

Following Blanchots line of thought this would be the final act of writing before the piece leaves me behind, as someone preceding the work, able only to write it not to read it, leaves me starting over again (Blanchot 1955). I am also confident that this research would benefit from the kind of critique provided by post-structuralism and feminism, due to, e.g., contradictions in the material. This, however, will be left to others to take care of.

Research process overview

The overall process for developing understanding for the field of use qualities as a theoretical as well as an empirically grounded construct is illustrated in FIGURE 3.

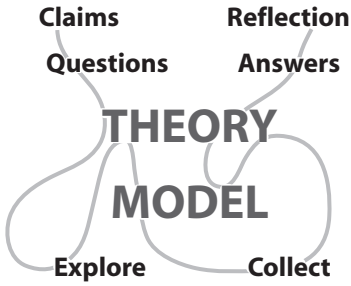


Figure 3. **A schematic overview of the research process**

The paradoxical findings in I.02 INSCRIBING THE RESEARCH PROBLEM (see also Holmlid 1995a), triggered a distanciation through theoretical investigations of conceptions of quality, II.04 QUALITY AS A PROPERTY OR AS IN USE and II.05 INTERACTIVE ARTEFACTS USE QUALITY, reported in parts in Holmlid (1997c). The purpose would be to create an epistemological and ontological grounding for the use quality concept. The main contribution is the development and synthesis of theory.

It also induced a more thorough examination of the empirical material from I.02 INSCRIBING THE RESEARCH PROBLEM (reported in Holmlid (1995b, 1997c, 1997d, Holmlid 1998)) which has been included in the appropriate places throughout the dissertation. The purpose would be to gain a better understanding for the paradoxical findings.

As another distanciating activity research on learning to use software and influencing factors were reviewed, parts of which occur in II.06 LEARNING AND CHANGE. The purpose would be to gain an understanding of research performed within the growing field of assessing learning in the context of using information technology. The main contribution of this work lies in the connections made between the growing area of IT learning and evaluations of use of software.

We participated in two training development projects, one in a collaboration with a consultancy, WM-data, and a bank, SPS, the other in a collaboration with the bank, FSB, with an increasing amount of intervention activities. We selected carefully, together with the project manager, the kind of development project, as well as participants in the development team, and the advisors, who acted as informants, at the local branches. These two projects served as the basis for four empirically based investigations, one from the first project, and three from the second project.

The first empirical investigation, III.07 EXPLORING USE OF WORD, in which ideas on use quality were introduced into a project group at a systems development consultancy and their customer, a bank, from the researcher in the role of being usability expert. In this first empirical investigation the use of Word was studied before and after training. The material was reviewed by the project group as well as the researcher, in parts reported in Holmlid (1998). This would contribute with material to the first sketches of a model of use quality, as well as in the light of the paradoxical findings in I.02 INSCRIBING THE RESEARCH PROBLEM, explore anew the possibilities and limitations of studying effects on usability induced by learning.

A modelling activity followed, included in appropriate places in II.04 QUALITY AS A PROPERTY OR AS IN USE, II.05 INTERACTIVE ARTEFACTS USE QUALITY and some in III.08 MODELLING TELLER SYSTEM USE, THE FIRST ROUND. This would transform the empirical material into one or several tentative models to be used as tools in the next empirical investigation.

This also spurred some side tracks which are not reported in the dissertation; a comparative reading of literature theory and HCI (Holmlid 1997), a draft research framework for social use qualities (Arvola & Holmlid 2000), a reflection over interactive art (Holmlid 2000), an analysis of genres as a tool for design (Holmlid, Arvola, Ampler 2000).

In the second empirical investigation a small project group of designers (and the researcher) used the ideas and models of use qualities and how

they could be used in design of learning environments to decide on a redesign of a learning environment, III.08 MODELLING TELLER SYSTEM USE, THE FIRST ROUND. This would contribute to the understanding of the applicability of the models developed earlier as well as contributing with newly developed models based on the practitioners perspective of what would be an appropriate understanding of use quality.

In the third empirical investigation the use of the software was studied before and after training, III.09 TELLER SYSTEM USE. This would contribute to the understanding of use qualities and the developed models based on studies of actual use, and provide a basis for assessment and modelling in the next empirical investigation. (Parts of this have been reported in Arvola & Holmlid (submitted)).

In the fourth empirical investigation, the material was reviewed and assessed by a larger project group, consisting of educators, researchers as well as systems developers, III.10 ASSESSING TELLER SYSTEM USE, THE SECOND ROUND. This would again, similarly to the second empirical investigation, provide practical applicability, assessment and modelling.

In parallel with this the implications part of the work, IV.11 RESULTS AND DISCUSSION, was performed as a distanciation activity. As an assessment of the value of the work performed in the research setting a critical view was posed upon the critical claims and the work as a whole, IV.12 CRITIQUE.

As will be evident, if it is not already by now, the timeline of the process is not reflected fully in the structure of the dissertation. Writing this book up became part of the critical and analytic activity, which also conformed the structure to cope better, though not fully, with genre standards, than would have the autobiographical account.

SECTION II – TREATISE

Varför hävdar varenda en att ett fickur är runt till formen, vilket är uppenbart felaktigt, eftersom det i profil framstår som en smal rektangulär form och snett från sidan som en ellips, och varför i helvete har man bara lagt märke till dess form i det ögonblick då man har sett efter vad klockan var? Kanske under förevändning att det var ändamålsenligt.

from Alfred Jarry, definition
in Patafysisk antologi by C. Hylinger

II.04

Quality as a property or as in use

In this chapter the basis for two conflicting views of quality will be charted out, as well as some of the more specific operationalizations. A wide range of issues will be presented, not on the basis of how they will be used in course of research, nor for their potential input to models later developed, but for the presentation of my development of knowledge about these two conflicting views.

The first section is a treatment of the view of quality as a property of the product at hand. The second section is a treatment of views that regard quality as emerging in product use.

Quality as a property of a product

When speaking of quality, it is often attributed to the product to which we are referring. Quality is a set of properties which that product has, such as its size; quality is a property of the product, owned by it. Products are in that way possessive.

Referring to quality in this sense, quality is objective in relation to the person referring to the quality (Dahlbom & Mathiassen 1993). A person's preferences do not alter the properties of the product, and are thus not qualities of that product.

Qualities, in this sense, are independent of what surrounds the product, and, unless specified as restrictions to a certain quality, independent of to what use we

put the product. Qualities are bounded by the product. That is, qualities are destructible, and are no longer present after the destruction of the product.

> *It is not surprising to find that computer system quality is almost totally focused on properties associated with reason...*
>
> Stolterman 1992, p 147

This is what is generally meant when speaking about properties. Here also the philosophical underpinnings of properties will be surveyed.

Primary and secondary properties

Generally it can be said that there are two major kinds of properties, primare and secondary. Primary properties, refer to those properties which are independent of our perception of them. Our perception of primary properties are true copies of the properties. Primary properties are properties such as size, shape, movement, number, *et cetera*. Secondary properties, refer to properties which exist through the interplay between our senses and the primary properties of that which we are perceiving. Secondary properties are properties such as colour, sound, smell, heat, taste, *et cetera*. Sometimes one is also referring to tertiary properties, which are properties such as good, nice, evil, beautiful, ugly, *et cetera*, solely dependent on our dependency, or our sociohistorical background (Lübcke 1988).

The way of looking at qualities of a product described above, rests heavily on this tradition. It has its distant roots in the reasoning of Plato and Aristotle. In Aristotle's view quality is one of ten categories, of which substance is the most important, that which is essential to a thing, and if it lacks the substance it is no longer the same thing (Lübcke 1988).

Subject-object dichotomy

The field of problems and the perspective for the property view of quality is collected from Descartes, Hume and Kant. And it is first and foremost

presuppositions about the relationship between man and the world and more generally about subject and object, *et cetera*, that distinguishes their influence on our way of viewing quality (Eriksen, Fløistad & Tranøy 1985). Descartes, and earlier Aristotle, without defining his ontology as objectivistic, believes that there is a clear distinction between the world, inhabited by objects, and a subject in the world, whereas more recent thinkers, such as Kant, Jaspers *et cetera*, clearer problematize the subject-object relation. For instance, Kant reasons that it is impossible to know anything about the thing in itself (das ding am sich) independently of the relation to an experiencing subject. In this way Kant makes it possible to criticize the traditional metaphysics of dogmatically transferring properties of the perceived to the thing in itself. Still, though, Kant strongly believes that there is a thing in itself independent of the thing as we perceive it, although the only thing we know is the thing as we perceive it. In this tradition of thought the existence is a priori our experiencing it; the world reveals itself to us, the world is there to be perceived. The world is an object which we stand before as subjects (Lübcke 1987a, 1988).

Product quality

Some definitions of product quality are nurtured by the property view. Here the framework from Garvin (1984) will be used as a way of structuring the argumentation, while others would have been possible, such as Dahlbom & Mathiassen (1993), Bergman & Klefsjö (1994), Juran, Gryna & Bingham (1974), Deming (1986) or Crosby (1979). While Dahlbom & Mathiassen provide a view clearly positioned within the field of information technology, the others are not positioned specificially within the field of IT. Bergman & Klefsjö provide four quality categories; quality of development, production, delivery and relationships. Juran define quality as fitness for purpose or use and a set of five quality characteristics; quality of design, quality of conformance, availability, safety and field in use. Crosby as well as Deming provide general definitions of quality, such as fitness for use, requirements conformance, or customer needs, and positions the solution to reaching high quality in the production

process. Garvin bring a more basic perspective of quality, what it means at a more fundamental level, which is the reason it is chosen as the primary source here; the others are more applied, focused or positioned while Garvin provide an extensive review and synthesis.

Garvin's (1984) product-based definition definitely is nurtured by the property view, as is the manufacturing-based definition. Other definitions do not necessarily purport a property view on quality, but do in some interpretations. Those are the user-based definition and the value-based definition, of which appropriate interpretations will be presented here.

PRODUCT BASED QUALITY. The product-based definitions view quality as something precise; a measurable variable at the product-level.

> *...differences in quality reflect differences in the quantity of some ingredient or attribute possessed by the product.*
>
> Garvin, 1984, p 26

Thus it is possible to constitute an order of quality for goods. However an unambiguous order cannot be produced unless the attributes in question are considered preferable by virtually all buyers (Garvin 1984). In effect, attributes reflecting tertiary or some secondary properties, are by definition problematic in the sense of constituting an order of quality. Consequently substituting quality with quantity is a way of making a category mistake.

MANUFACTURING BASED DEFINITION. The manufacturing-based definitions focus on the supply side. By being concerned with engineering and manufacturing practice, poor quality can be avoided; deficiencies need not be introduced.

Virtually all manufacturing-based definitions identify quality as "*conformance to requirements*". Once a design or a specification has been established, any deviation implies a reduction in quality. Excellence is

equated with meeting specifications, and with "*making it right the first time*" (Garvin 1984, p 28)

The presupposition of this approach is that we can make a design or a specification, and more importantly that we can tell what a deviation from the requirements are. Thus there is a need for techniques of ordering products in relation to the requirements, either by adopting a product-based definition, or by adopting a subjective judgement on the deviance from the requirements; in turn this requires the specification to tell who is to judge. It is as easy in this approach as in the product-based approach to substitute quality with quantity without due attention. Still more so when working in larger teams, where the person who formulated the requirements is not the person to manufacture/implement what is supposed to conform to that requirement. The quality is easily lost on its way from mutual understanding between those people formulating the requirements to the finished product, in the very process of formulating the specification. There are lots of conventions, tacit knowledge, shared experiences, processes of compromising, never revealed to a reader who has not participated in the writing of the specification. It is fairly easy to agree upon the overall goal of the manufacturing-based definition, that improvements in quality are equivalent to reductions in number of deviations (Garvin 1984). In order for this to become a factual endeavour tests need to be designed, standards set, and again we rely on our ability to define quality in terms other than themselves.

In both approaches; it is not guaranteed that a piece of software, devoid of every fault, has any qualities in use whatsoever, although a fault free substance.

USER BASED DEFINITION. The user-based definition views quality as being related to the individual consumer's wants and needs.

> *...[it] faces two problems. The first is practical – how to aggregate widely varying individual preferences so that they lead to meaningful definitions of quality at the market level. The second is more fundamental –*

> *how to distinguish those product attributes that connote quality from those that simply maximize consumer satisfaction.*
>
> Garvin 1984, p 27

Aggregation is often solved by statistical analysis of a larger consumer body, resulting in that the product meets the needs of the majority of consumers. This is an approach much alike finding the largest common denominator (Garvin 1984). Depending on how we proceed to find that denominator, what the denominator turns out to be, and how we use knowledge of that denominator we may choose to view that denominator as a quality which our product should possess in order to fulfill the needs of the consumers. Here we run both the risk of specifications from the manufacturing-based definition and the substitution problem from the product-based definition.

VALUE BASED DEFINITION. The value-based definition views quality in relationship to value. The result is that quality is the degree of excellence that can be afforded.

> *They ... define quality in terms of costs and prices. According to this view, a quality product is one that provides performance at an acceptable price or conformance at an acceptable cost.*
>
> Garvin 1984, p 28

This approach take a product perspective, as well as a process perspective, and thus can be viewed as a way of combining the manufacturing and the product definitions. In its simplest form the question of this approach is if it is worth to spend thousands of dollars on finding faulty components before they become an integral part of a product. In its more elaborated sense we would be asking ourselves when the cost of finding faulty components are greater than the cost of the resulting rework, scrap or warranty expenses. (Garvin 1984) It is easy in this approach to substitute the qualities for something that is easier to measure. That is, it supports the

view that it is of minor interest to formulate complex secondary or tertiary properties as goals for the production of software. This standpoint is based on the belief that we have no possibility to deliver or construct anything else but primary or psychologically certain secondary properties. Therefore it is fruitless trying to do anything else than that which we know we can do. It becomes the problem of the customer, or marketing, or support, *et cetera*, to handle the integration of the product into its sociohistorical context of use.

Quality as in use

There is less general understanding of what quality means, in a sense of quality-in-use, the notation bearing connotations of both German and continental philosophy. It can be suspected that this knowledge of use quality is tacit, and dependent on the amount of experience a person has from evaluating the use of a product. Indirectly there might also be a link between the lack of orality in relation to a predominant literacy, which has influenced us so as to value the objectification, abstraction and categorization, before the use and usefulness (see Ong 1990). That is, the predominancy of literacy makes us see a product primarily as an object instead of seeing it in and for its use. Ong (1990) speaks about orality and literacy as one piece of which culture consists. He refers to research conducted showing that persons which are oral (cannot read or write) cannot distinguish objects from each other with other aspects than what they are used for; a saw, an axe, and a log, is not distinguished from each other as tools and tree, but are seen as one group because they are useless without each other.[1] Or, as Hård af Segerstad (1957) expressed it;

> *Man without artefacts are helpless, but artefacts without man are meaningsless.*
>
> Hård af Segerstad 1957, p 15, my transl.

1. Similar results are found by Luria in his experiments with, e.g. geometrical shapes.

In the concluding section of this chapter some approaches to use quality, encompassing disparate senses of quality will be addressed. Deserving to be repeated is that the two views on quality presented in this chapter give two interesting voicings to quality, and could, or even should or need to, be used in parallell contributing to the understanding of software quality in each specific case. The main objective is to introduce use quality in a more direct and definite way, reasons of which the previous chapters speaks clearly; The quality as property view supports construction views of software engineering, with mechanistic ways of production, whereas the use quality view supports value views of design.

> *Artifacts, in a human activity framework, have a double character: they are objects in the world around us, which we can reflect on, and they mediate our interaction with the world, in which case they are not themselves objects of our activity in use.*
>
> Bannon & Bødker 1991, p 242

In the case of, e.g., HCI this approach puts emphasis on the use of a computer application, rather than merely the nature of the interface as such.

Clearly it is not sufficient to have either the production focus or the product focus. There is a need of finding a way of paying attention to them both without losing focus or getting stuck in between them. It is also insufficient from a use perspective to focus merely on the effectiveness of the process; we need to look at both the effectiveness and efficiency of the product and the process. If we are to talk about use quality we need to have an eye on the product when it is used in a customer organization. Callaos & Callaos (1994) describes an approach which tries to encompass all those aspects.

Figure 4. **The user/client dimension**

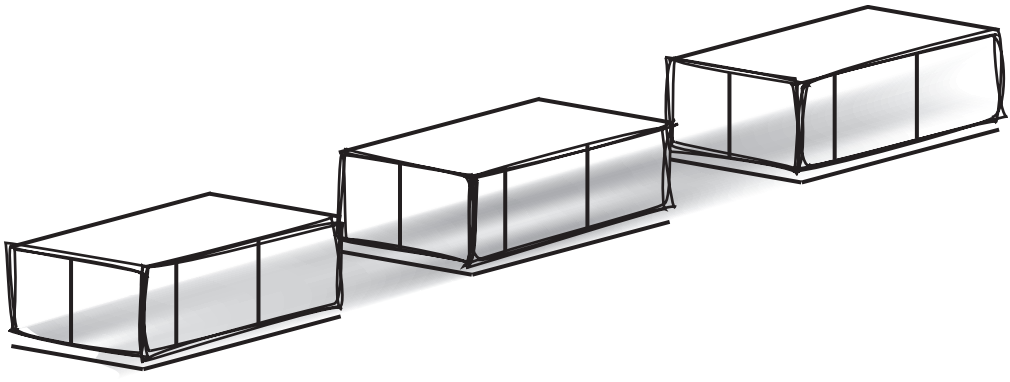
Table 1: **The systemic quality cube**

Quality orientation **Quality object**	**Efficiency** **inside the system, system structure**	**Effectiveness** **outside the system, system environment**
Product	Objective: maximize product-efficiency Constrained by: product-effectiveness	Objective: maximize product-effectiveness Constrained by: process-efficiency
Process	Objective: maximize process-efficiency Constrained by: process-effectiveness	Objective: maximize process-efficiency Constrained by: external restrictions to the process

Systemic quality cube

Callaos & Callaos (Callaos & Callaos 1994) provide a framework for iterative design based on a total quality approach, called systemic total quality. As a starting point they provide a two-dimensional framework consisting of product/process and effectiveness/efficiency, see TABLE 1. The objective of maximizing product efficiency is constrained by the product effectiveness, that is, it does not matter how correctly the software adds if adding is not the correct operation of the software. They also acknowledge that the user and the client may have different aspects and needs of quality. The user/client makes up a third dimension (FIGURE 4), resulting in a cube, the systemic quality cube, SQC. A fourth dimension is later introduced , consisting of a timeseries of cubes, including evaluation of quality and rework (FIGURE 5).

Figure 5. **The quality cube over time**



Callaos & Callaos (Callaos & Callaos 1994) do not explicitly mention use quality, but make several comments on Total Quality Management and Quality Function Deployment, QFD. The SQC is not explicitly a property approach to quality, but is most easily used as such; the looks of the SQC is easily transformed into QFD matrices. But the SQC can readily be used for use quality approaches. First of all, in every square of the SQC the explicit introduction of a property view and a use quality view will make it possible to formulate those two aspects separately from each other, and will force the designer to think through what those aspects mean. Both aspects should also be defined with both objective and subjective criteria. Secondly, the square process/effectiveness implies use qualities, and has direct links to SQCs as they can be set up in the user organisation, for their products and processes (FIGURE 6). By starting out with those SQCs, relationships with the other squares in the software company's SQC will be discovered. As a result the qualities from the beginning will be focused on the actual use in the user organisation.

Kitchenham & Pfleeger (Kitchenham & Pfleeger 1996) suggest that external product behaviour is equal to use quality. With external product behaviour should be understood behaviour of the product which can only be measured with respect to how the product relates to its environment (Fenton 1991). This view allows us to define the relation between the product and its environment according to, e.g., Kant's three categories of

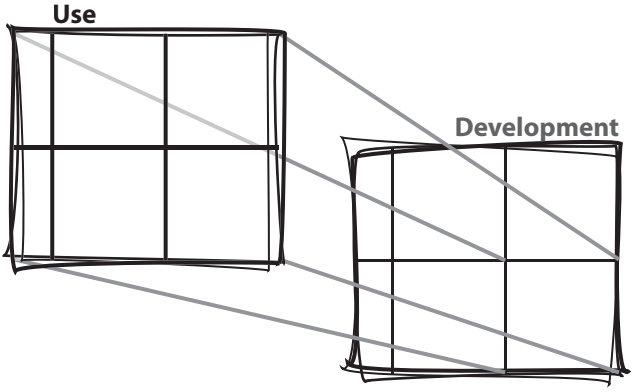


Figure 6. **How the use quality cube fits into development quality**

properties (cs. PAGE 50). Most often though we stop at an intermediate level, with quality as an inherent characteristic of the product; with a model of quality consisting of secondary properties, functionally decomposed into primary properties. This is a fact that Kitchenham and Pfleeger (Kitchenham & Pfleeger 1996) recognize; many quality models face problems of completeness and consistency, and they are often untestable. While accepting a modeling approach these are the problems that we have to face.

One important aspect of Kitchenham and Pfleeger's approach is what the environment is, and how we view that in relation to the product.

> *… the system is constrained by the function's cost and availability, as well as the environment it will be used in.*
>
> Kitchenham and Pfleeger 1996, p 15

In the case of a massmarket software product it might be useful to view the environment of use as a constraint, but in cases other than those where the relationship between the producer and the client/consumer is characterized by impersonality, the environment of use should be viewed as a prerequisite of the system.

Outcome of development

Simmons (1996) attacks the problem, so delicately introduced by Bryn-jolfsson (1993) and so thoroughly considered by Strassmann (1990), of trying to find out how good business and IT investments go together. She ends her article by saying

> *Software that is defect-free and created using quality processes is of little use unless it also provides the accompanying business value.*
>
> Simmons 1996, p 32

She wants to focus on the third level of quality, the outcome of software development, which perhaps is the most interesting aspect (see also 150

14598-1 and the effect of software). Outcome is related to how the software is used, and determines the business value of the development project. Simmons presents a framework for classifying benefits and ways of evaluating those benefits, see TABLE 2.

Table 2: **Five types of outcome of software development**

Type	Benefit	Measure
Increased efficiency	Benefits attributed to cost avoidance or reduction	Economic, through cost avoidance or cost reduction
Increased effectiveness	Such as providing better information for decision making	Economic (resulting from the use of the information) key performance indicators (if value-based management has been implemented)
Added value	Benefits which enhance the strategic position of the organization (such as increased market share due to better product differentiation or the creation of entry barriers)	Usually no direct measure for IT system alone; evaluate return from the entire business strategy
Marketable product	Development of a marketable product or service	Economic, through establishment of market price
Development of corporate IT infrastructure	Such as communication networks, hardware, database environments that provide little direct benefit themselves but are required as a foundation for other systems	Usually no direct measure; corporate policy decision

In Goodhue & Thompson's study (Goodhue & Thompson 1995), they conclude that to predict performance both task-technology fit and utilization must be included. They also discuss the relevance of using IS success measures as surrogates for performance impacts of a system, and that:

> *When users understanding the business task is involved in systems design, it is more likely that the resulting system will fit the task need. Thus, user involvement potentially affects not only user commitment, but also (and in a completely different way) the quality of fit of the resulting system.*
>
> Goodhue & Thompson 1995, p 230

What seemed to be most important for the companies that participated in Simmons' study were that investments in IT projects should be linked to corporate strategy.

> *In each case, the evaluation procedures were flawed because they neglected to explicitly consider the extent to which the project supported their organization's strategic objectives.*
>
> Simmons 1996, p 31

Simmons' five types of outcomes of an investment in information technology, used as a collaborative tool between customer and producer, would give a broader sense of quality, relating to the use of the interactive artefacts. In this dissertation I will not deal with issues such as corporate strategy, IT infrastructure or marketing directly. Briefly, though, one may notice that the rhetoric of the benefits of usability work most often circles around Simmons' first and second type of outcome.

The experiencing subject

One central position in reasoning about use quality is the question of the inseparability between the subject and an object. Berkeley says that primary properties also are dependent on the experiencing consciousness. Husserl elaborates this, and says that because our life-world is characterized as well by smell, heat, sound, colours, *et cetera*, as by viewable forms and because this world of life is a requirement for making it meaningful to speak about an abstract world, every property is dependent on the experiencing subject (Lübcke 1988).

Kant, strangely set in both the property section and this section, criticizes the traditional metaphysics of dogmatically transferring properties of the perceived to the thing in itself. Kant believes that the only thing we know is the thing as we perceive it. Nothing exists independently of the relation to an experiencing subject. Kant also suggests that every such relation can be characterized by reference to the truth, the good, and the beautiful (der reinen Vernunft, der praktischen Vernunft, der Urteilsk-

raft). This may take the form of a subjectivism, but may also be used as a way of categorizing the experiences of the use of objects (Lübcke 1988).

Returning to the things themselves

Heidegger claims that the property to exist cannot be isolated from that which one is existing in without being meaningless. Objects are objects-in-use to start with. This definition is to prevent objects from being separated from the human being. The subject exists "in" the object as its user. An object in use is an object which we use for a specific purpose. It is situated in a functional context which has the effect that the objects refer to each other. Our understanding of the superordinate goal, of the situation and our task direct the specific operations. That is, it is the functional context of our understanding that is the basis for the understanding of the use of the individual object. Objects we use are often made of others and of other things and materials, which means that we need an understanding of other people and of nature. The functional context thus is the subject, other people and nature (Eriksen *et al* 1985).

One thing all these objects-in-use have in common is that they are usable for something, which Heidegger terms the objects' toolness, its tool structure or its tool character. An object can only have a meaning because this meaning can be discovered in an activity with the object-in-use that is meaningful to us. (Lübcke 1987a)

Into contextual settings

By looking at descriptions of conflicts in postwar analytic philosophy, here described in the view of Strawson, concerning whether meaning can be found in language as words or through the use of language. Through analogical reasoning we can get a feeling for the difference between quality as a property and quality in use. Strawson points out that 1) the concept of meaning can only be satisfactorily clarified through reference to a set of rules that users of language have to know to be competent in language. According to this the rules are not rules of communication but rules on the truth of sentences in language. 2) It is

impossible to clarify the concept of meaning without reference to the communicative intentions of the user of language (Lübcke 1987b). That is, in analogy, quality is dependent on the users, their more or less competent use of the object, their competence of the rules of the situation of use, and their intention of using that object for that specific use. Strawson also points out that singular objects have a structure and a context that is different from the structure and context in which different people experience and perceive the objects.

Wittgenstein, during his later activity as a philosopher, argues that the meaning of an expression is its use; the meaning of a sign is the way it is used in a language game. Thus it is generally not possible to ask oneself in a meaningful way what reality consists of independently of a certain language game (Lübcke 1987b). Software quality is in this way of reasoning both part of different language games, such as software engineering, and a language game in itself.

Gadamer defines experience as a central term. Experience is a historic quantity. The human life-world is the sum of an individuals experiences. Every new act of experience is constructed from a context (the life-world), in which some components serve a more direct role in the new act of experience, than does other components. The new act of experience have repercussions on all your life-world, it is not possible to repeat an experience. Every persons life-world is in turn influenced by the larger (local, national, *et cetera*) culture. An act of experience is a step in the history of individual and the larger cultural development, everyday actions at least contribute to keeping a form of life and culture. Historical assumptions influence our experiences without us being fully able to take them into consideration. For Gadamer it is important to clarify these assumptions in order to say something about an object (Eriksen *et al* 1985). We will never be able to be certain that we have understood enough of these assumptions when describing an experience. Or if there is a final assumption, an assumption from which all other assumptions stem, we will be able to tell when we have formulated that assumption (Eriksen *et al* 1985).

Activities

On one hand, Habermas, in contrast to the objectivists, believes that the foundation of knowledge is in the human context of actions. On the other hand, he objects to the subjectivists by stating that knowledge comes from the context of actions which are prerequisites by nature. For Habermas there are three kinds of actions; the goal-oriented act, the normative act, and the expressive act. An action is seldom possible to describe in terms of one of the kinds of actions. Every act is at the same time goal-oriented, expressive and normative. As such they can be viewed as qualities of the use of a certain product. (Lübcke 1987a, 1988)

Bergson states that the difference in time between repetitions of what seems to be the same experience is not a difference in degree, but a difference in kind. Bergson are of the opinion that subject and substance is an immediate unity. It is thus this unity that has qualities which we are interested in, and one of the major qualitative differences between experiences are the difference in time. (Lübcke 1987a, 1988)

Illustration

An example of the difference between the property perspective and use quality is the following. We do not build objects but uses. We are not primarily interested in constructing hoovers, but allowing for cleaning through hoovering. It is in the lack of usefulness we discover the hoover as having propertie of its own. It is in the breakdown we discover the hoover as an object. It is not until we are hoovering that we experience the qualities of different hoovers, and the qualities result from that experience only. We might also experience the hoover in quite a different way, as an object to reflect upon, putting it to an intellectual use, thus establishing a different set of use qualities. In line with Heidegger we would say that talking about hoovers is only meaningful in a world where it is meaningful to distinguish between clean and dirty.

In this illustration the property view is one way of reflecting upon hoovers, thus putting it to an intellectual use. The use qualities can only be experienced through the actual use of the hoover. Every use quality is pri-

marily related, sprung from, what we want to achieve through the use of the hoover. Reflecting upon that use is in turn to put the usage to an intellectual use, as is observing the use from a distance.[2]

Garvin's framework revisited

Looking at Garvin (1984) again we have already stated that not all of the quality definitions he presents are based on the property view. The other approaches are the transcendent, the user-based and the value-based.

The transcendent definition views quality as a platonic form.

> *[Quality] is both absolute and universally recognizable, a mark of uncompromising standards and high achievements. ... that we learn to recognize through experience.*
>
> Garvin 1984, p 25

Quality in this view is logically primitive, and can be understood only in terms of itself and only after one is exposed to a succession of objects that display quality. Quality in this sense is something absolute and universally recognizable and thus it cannot be a property of the product. Quality only shows through experiencing the product (Garvin 1984). The act of recognition becomes the epicentre of a quality discourse; what is required of a quality assessor, the situation of assessing, the assessment as such and the communication of the result, in order to recognize quality. Recognition is concerned with what things are, rather than what they appear to be. Quality in this sense resides outside of history and time. Thus there is no quality that is specific to software, but software is in turn specific to quality. In practice this carries with it the risk of becoming an elitist approach, where the producer has the upper hand, or consensus rules what quality is; where the highest good is the contemplation of ends, rather than getting involved with things.

2. The example used is a simplification in relationship to the use of most interactive artefacts we are used to. The simplification is used for the sake of clarity.

The user-based definition views quality as being related to the individual consumer's wants and needs.

> *...[quality relates] in the operations management literature, to the concept of "fitness for use."*
>
> Garvin 1984, p 27

This concept face the same problems as the user-based approach under the quality as property view (cs. PAGE 53 *"...[it] faces two problems..."*). Focusing on fitness for use, and techniques for assessing that fitness and that use, would be a leap forward for quality in use. It would be a combination of a focus on the product as it is used, and a focus on the process of finding out about that use, as well as how to produce an artefact for that usage. Another activity would be to have an early focus on the resulting use as a benchmarking/prototyping activity. In many cases though the user-based definition remains merely a personal view of quality, which is highly subjective. It is not unproblematic to equate quality with maximum satisfaction. While being preferable to a product that meets fewer needs, the product maximizing satisfaction is not guaranteed of being the better (Garvin 1984).

The value-based definition views quality in relationship to value. The result is that quality is the degree of excellence that can be afforded.

> *They ... define quality in terms of costs and prices. According to this view, a quality product is one that provides performance at an acceptable price or conformance at an acceptable cost.*
>
> Garvin 1984, p 28

Zultner (Zultner 1993) states that there are basically four kinds of values; Solving problems, seizing opportunities, looking good to significant others, and feel good.

> *Any software that does not help the customer in at least one of these four ways is valueless*
>
> Zultner 1993, p 80

The value-based approach take a product perspective, as well as a process perspective. The actual usage of the product and the price to which to customer can purchase the product are the conditions defining what quality is. In contrast to the user-based approach (cs. page 53), studying the actual use of a product in the value-based approach not only is concerned with the fitness to the individual users actual use, but also with the fitness to the strategic use of a company; fitness to the value-adding activities required for a company to achieve its goals.

'nothing' the unjust man complained
'is just'('or un-' the just rejoined

34 in 73 poems by from ee cummings

II.05

Interactive artefacts use quality

This chapter reviews a set of literature that in one way or the other treats the use of artefacts. The goal is to produce a tentative understanding of what use quality for interactive artefacts consists of.

The chapter is divided into four parts. The first circles around a reading of three classical works on modernist or Scandinavian design. The second takes as its starting point Susan Lambert's book Form follows Function. The third is a review of existing views on use quality of interactive artefacts. The last part tries to synthesize the knowledge gained in this chapter, and proposes one tentative model of use quality which is used for empirical purposes, and as an analytical tool for assessment and discussion.

Artefacts

This part circles around a reading of three classical works on modernist or Scandinavian design; *More beautiful everyday goods* by Paulsson (1919/1995), *The character and use of things* by Paulsson and Paulsson (1957), and *The things and us* by Hård af Segerstad (1957). The readings are done of the original texts in Swedish, all translation are done by me, even though some translations of these works are available.

The use of artefacts

First of all Paulsson & Paulsson make clear that every artefact is used in some way. They continue by defining three different kinds of use of an artefact. The *practical use*, which has to do with us using an artefact. The *social use*, which has to do with us being with an artefact. The *aesthetic use*, which has to do with us looking at an object or contemplating over it. To understand this a little better, they will be elaborated upon somewhat, partly by introducing the character the use takes, and the corresponding form concepts.

PRACTICAL USE. Practical use has to do with when we use artefacts. When we are considering tools, they should be characterized by effectiveness, that they are appropriate for the actions they are used in, i.e. tailored to fit the hand/s, the material which is worked on, adapted to other tools used together with it, *et cetera*, that they are appropriate in relation to what one wants to achieve (Paulsson & Paulsson 1957), and that the purpose of the tool is clearly expressed in its form (Paulsson 1919).

Hård af Segerstad talks about the practical function of an artefact. Such a practical artefact "*has an apparently practical role to fulfil and because they are used for more or less determined purposes. They possess a function, or rather several functions.*" (Hård af Segerstad 1957, p27)

SOCIAL USE. Social use is characterized by symbolic values. These values creates a design space where it is possible to, e.g., design larger and posher offices for management than their practical use of the offices requires. The social use can be described by the regions in which it occurs, such as the region of social intercourse, or the region of work. Different regions assume specific attitudes, feelings and values, which in turn directs an individual's actions, and thus produces different actions in different regions if one knows the rules.

A similar notion of use is held by design critic Reyner Banham.

> *For him, use was less a case of primary function, than of social context and meaning – the way in which design was used or consumed by particular groups. Use was a decidedly human aspect of design, not just a quasi-ergonomic one in which an object's 'nature' – by which modernist designers tended to mean the graspability of a handle or pourability of a spout, for example – helped shape well-proportioned and handsome form.*
>
> Whiteley 1997, p 26

He also believed that it was through an artefact's social use one could assess its symbolic value.

AESTHETIC USE. Aesthetic use is when one experiences a thing by looking at it, feeling its surface, or other contemplating/experiencing activities. Aesthetic form should never be added to practical form, i.e. aesthetic form should follow practical use. It should definitely not go against practical use by its own rules, independently from practical use.

This function of an artefact is referred to by Hård af Segerstad as a psychological function. He refers to Susanne K Langer (1953) saying roughly "*The world as exclusively aesthetic surface is seldom, if ever, the only object of our attention.*"

Design critic Banham agrees once again, "*aesthetic value is not inherent in any object, but in its human usage*" (cited in Whiteley 1997, p 26)

SYMBOLIC USE. In addition to the three main uses identified by Paulssons, Hård af Segerstad pronounces the role of the symbolic value as another kind of use. For Paulssons the symbolic value mediates the social value.

Every artefact exists in all three uses, in differing amounts across time, users and space. Paulsson & Paulsson argues that the social situation for

an artefact enable the design for aesthetical and social use possible. The aesthetic form creates symbolic values which in turn is assumed by social use. For Paulsson & Paulsson practical use and social use are at two ends of a continuum, every object can be placed on this scale. Above that there is the symbolic value. The more important the practical use is, the less freedom there is for aesthetic form; the more symbolic value the more room for aesthetic form (aesthetic form should here be understood in its more ornamental senses). Hård af Segerstad, on the other hand, puts the practical function on one end of the continuum and the psychological function on the other.

Both Paulssons and Hård af Segerstad hold the opinion that there is a wholeness to designing artefacts, Hård af Segerstad states "*Artefacts around us function with maximum effect, only when they are appropriately organized into a total milieu.*" (Hård af Segerstad 1957, p 38).

But Hård af Segerstad modifies his position by stating that a well organized total milieu cannot be one where there is extreme homogeneity without variation. He argues that there is need for a conscious and delicate balance between wholeness and the free interplay between the constituent parts. Paulssons closes this line of thought by connecting back to the user

> *Only by clarifying the relationship between an artefact and the person who is going to use it, it is possible for me to form an understanding of the value of the artefact.*
>
> Paulsson & Paulsson 1957, p 120f

Designer, roles and processes

Already Paulsson stated that "*Theoretically it should be clear that the design of utility goods should be entrusted the design specialists of the society.*" (Paulsson 1919, p 37). He viewed art as a conservative way for design, and technology as a radical way. That is, as so many other at this time, he wanted

design to be less ornamental, and more adapted to the possibilities and inherent characteristics of new materials and new production processes.

Almost 50 years later he argues together with his son, that designing for practical use is a totally rational activity. They also describe an industrial production situation where the model building activities are separate from and precedes production. A consequence of this is that the design activities have been separated from the craft of producing the artefact, and has become an activity for a specialist. The designer still needs to understand the conditions of the production process (Paulsson & Paulsson 1957). This expression is similar to an interpretation of early 20th century design debate made by Lambert:

> *"… the division of labour encouraged by their [the craftsmen's] management had tended increasingly to separate making from responsibility for the appearance of the product."*
>
> Lambert 1993, p 15

Paulsson & Paulsson (1957) argues that the designer and the engineer plays complementary roles in giving artefacts their character. They also define three styles of consumption of things. An eager style, in which the user eagerly adopts everything that is new, to show that s/he is a little better than the others around her. An anxious style, in which the user clings to a conformity defined by the group s/he belongs to. And an autonomous style, in which the user regardless of the group chooses things for the best fit of its purpose, be it social, aesthetic or practical. Paulsson & Paulsson believe that it would be best if all people could be autonomous. The autonomy is hard to uphold, because sooner or later the design one chooses will have a history. So, either the autonomous user needs to change all the time, or we just might want to reformulate the definition to correspond to a person that consumes design for individuality.

Hård af Segerstad heavily criticizes Paulssons' notion of consumption styles; he believes that they uphold the difference between a design elite who knows what good design is (the autonomous style) and those who

don't. He also believes that one single person will travel between styles of consumption. The reinterpretation above is less controversial from Hård af Segerstad's perspective. He defines himself a functionalist as a person who starts his design task by as thoroughly as possible study the functional aspects of the design task at hand and at the same time with all due respect to the unexpected variations of the human factor refuses to get stuck with a style or with patent solutions. He continues "*His contrast, the traditionalist, then is someone who without critique accepts given forms – be they old or new – and who lacks in independence, copies and imitates them.*" (Hård af Segerstad 1957, p 48)

According to Paulsson & Paulsson the "*Designer is especially competent to let the form speak the language that corresponds to the function and the situation, but his task is not restricted to the aesthetic expression. It is to give form to the practical, manufacture-related and social demands or expectations on the artefact in such a form that it will become as far as possible a non-contradictory wholeness. This is a creative process, impossible to perform without aesthetic judgments.*" (Paulsson & Paulsson 1957, p 100)

Form *vs.* function

The form *vis à vis* function discussion has a long history. One of the most important pieces dealing with this is the Roman architect Vitruvius' *de Architectura*. Susan Lambert (1993) remarks on the influence of Vitruvius

> *… a Roman architect of no special significance were he not the author of the only architectural treatise to have survived from antiquity.*
>
> Lambert 1993, p 7

Variations on Vitruvius' theme have reverberated throughout history; Alberti proposed unity, proportion and suitability in 1452; Choisy proposed commodity, firmness and delight in 1909 (Lambert 1993); and in the late 20th century we find echoes of Vitruvius in structure, function and form (see e.g. Ehn 1995, Ehn & Löwgren 1997).

Paulssons as well as Hård af Segerstad discuss the divide between form and function. Paulsson (1919) argue that rationally made artefacts, i.e. artefacts that primarily are made for practical use, brackets form, and that the purpose of an artefact should be clearly stated in the form of the artefact.

Hård af Segerstad puts, in a classical manner, the practical function on one end of a continuum and the psychological/aesthetic function on the other. He also argues that there should be no contradiction between usefulness and beauty, they should not be regarded as either or, but as as well as. He claims that

> *… it is not only unsatisfactory but also empirically improper to divide our existence in irreconcilable sections of appropriateness and beauty. By that we legalise a double standard vis à vis artefacts, that allows us to accept ugly factories, dull offices, clumsy working chairs and poor tools, only because we can refer to elegant private houses, delicate shop-windows, exquisite furniture and perfect instruments.*
>
> Hård af Segerstad 1957, p 35

He describes function as the way in which an artefact fulfils its purpose, and that it is functional if the artefact is appropriate for its purpose. He also argues that there is not a function that completely, without remainders, can be expressed in one and only one form.

Paulssons become rather specific when they discuss the divide. They identify function and fictitious function, form and borrowed form, and meaning and inferred meaning. Souvenirs borrow their form from practical objects, and exposes a fictitious function; they are not intended to be used for the function they exhibit and might even be of too low quality to be able to be used for that purpose. Meaning, such as symbolic values, once interpreted by the use or appearance of an object is no longer available, but an inferred meaning has taken its place; such as the transition of meaning using a diadem, which once was a sign of a specific standing

(only worn by royalties) over a sign of wealth to its complex meaning of today (as a toy, jewellery, *et cetera*).

Hård af Segerstad again

> *As can be inferred from what has been said above the design of an artefact probably never can be broken down exclusively to considerations of practical functionality.*
>
> Hård af Segerstad 1957, p 48

Lambert (1993) points out that during the different epochs the focus of designers have shifted between form, function and structure, and combinations thereof.

The maxim "form follows function" which has been attributed to the Modern Movement, is discussed at length in Lamberts book (Lambert 1993). She also points out that the designers of the Modern Movement had a more complex apprehension of these concepts.

> *In fact an attentive reading of Le Corbusier's writings makes it clear that he did not equate functional form with beauty: 'When a thing responds to a need, it is not beautiful; it satisfies all one part of our mind, the primary part, without which there is no possibility of richer satisfactions' …*
>
> Lambert 1993, p 24

Lambert quotes Le Corbusier (1923/1946). In a later passage she claims that the reason behind Le Corbusier's choice of using the primary forms for his designs was not one of their link to utility but for their formal impact and qualities. Still, this preference, that was shared be many of the Modern Movement designers, created a style, easily recognizable, and in Paulssons terms possible to consume.

The tension between the three distinctions, and variations thereof, will continue to be an issue for designers as well as design research. It might even be the case that it is precisely this that is the condition for

doing design at all as well as for keeping the mystery and interest for design alive.

IT use quality

Some conceptions of use quality have been developed, although they go under other names. They find a heavy and contemporary heritage in Heidegger and the later Wittgenstein, but also in Vygotsky and mediated action, or Leontjev and activity theory.

As we are now turning our attention more towards machines, a few comments from "Swedish Modern" is appropriate. Paulssons write, when they relate aesthetics to machines, "*What can be done aesthetically through design regarding machines is on the one hand to clean up, to take away decorative ornaments /…/ On the other hand design is to make the machine more pleasant to work with.*" (Paulsson & Paulsson 1957, p 79f). Looking back at Paulsson, he seems to have a more elaborated view on this when speaking of the production of design goods.

> *The interest from the workers should not be difficult to cultivate, while the worker gladly embraces those changes that might make his work more pleasant. In some cases the designer's interests collides with those of the worker, i.e. when the former wants to get rid of a whole technique, and by that making a skill unnecessary.*
>
> Paulsson 1919, p 44

First a few short paragraphs on a set of conceptions of use quality. Then three notions will be more thoroughly described, Ehn and Löwgren's design for quality-in-use, Löwgren & Stoltermans notion of use quality, and Bannon and Bødker's activity and artefacts-in-use. I will summarize each and make brief reflections.

Short stops

Alben presents a framework for quality of experience, "*By 'experience' we mean all aspects of how people use an interactive product …*" (Alben 1996, p 12). She continues to describe the scope of those aspects; "*the way it feels in their hands, how well they understand how it works, how they feel about it while they're using it, how well it serves their purposes, and how well it fits into the entire context in which they are using it.*" (Alben 1996, p 12). Looking at the criteria she formulates[1] the kinds of uses they represent go far and wide. Most notable are, the adapting use (criterion mutable), the managing use (criterion manageable) and learning use (criterion learnable and usable). The specifics of the criteria were later modified by Kerne (1998) to include cultural representation. He also introduced this as a separate criterion, i.e., introducing a cultural use.

In the ISO definitions of usability a concept of quality in use, is introduced. It is defined as: "*The 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*" (ISO 14598-1). In Bevan (1995b) three levels of quality are proposed. »Operation», which is quality as it relates to the operational environment of the software, »external» which is quality as it relates to designing the software, and »internal» which is quality characteristics that might be expressed in general principles or specific details of implementation (also in ISO 14598-1). In early drafts of ISO 9241-11 the quality of a work system in use was proposed as "*the extent to which specified goals can be achieved with effectiveness, efficiency and satisfaction in a specified work system.*" (Bevan 1995a, 1997). This assumes a shift in focus from usability definitions given, in that it does not treat the parts of the work system as fixed. Bevan & Macleod (1994) say "*It is not meaningful to talk simply about the usability of a product, as usability is a function of the context in which the product is used. /…/ Usability is a property of the overall system: it is the quality of use in a context.*" One is supposed to use the measures effectiveness, efficiency and satisfaction to assess quality of use, and users, task, equipment and environment as context of use compo-

1. The criteria used in ACM/interactions design award were Understanding of users, learnable/usable, needed, mutable, effective, appropriate, aesthetic, manageable

nents (ISO 9241-11). In both Bevan (1997) and Bevan & Bogomolni (2000) a reference is made to the "*effect of the product*". The effect is made in the contexts of use, and answers to user needs. It is adopted from ISO 14598-1 (1998) where quality in use is the objective, and software quality is the means of achieving that. With quality in use is meant the quality which is achieved when a software product is used in a specified context of use. The figure of thought, what the effect of a system is, is powerful.

Henderson (2000a, 2000b) suggests that as a designer one should use six dimensions to understand people's activities in using technology. These are used in the articles to address three aspects of use; operating, enabling, and empowering. The six dimensions are; Trouble, Users enabling, Support, Practices empowering, Values, and Designers.

> *The first two aspects of activities (operating and enabling) address what must be done. The third aspect addresses why it should be done.*
>
> Henderson 2000b, p 27

Lundequist (1992), referring to Roger Scruton, proposes six aspects from which one might view architecture; function, form, structure, place, politics and public. These can be viewed as different uses of an architectural artefact. Being aspects none can be excluded from architecture. Put another way, it is possible to choose to view a building without taking into account the function of the building, but then one is not looking on the artefact as architecture.

Alexander (1970) writes, among other things, about the mutual adaptation of form and context, in order to achieve fitness between them. That is, when speaking of design one cannot speak of form only, but also speak of context, or rather the ensemble form-context and the division between them. For a given object, Alexander uses a kettle as an example, two contexts are identified; its use context, and its production context. He also

states that the designer should seek a problems earliest functional origin to be able to solve it. Again the kettle example;

> *But I can easily make changes in the boundary. If I say that the kettle is the wrong way to heat domestic drinking water anyway, I can quickly be involved in the redesign of the entire house, and thereby push the context back to those things outside the house which influence the house's form. Alternatively I may claim that it is not the kettle which needs to be redesigned, but the method of heating kettles. In this case the kettle becomes part of the context, while the stove perhaps is form.*
>
> Alexander 1970, p 43

Several other sources can be read to identify and interpret use qualities. Krippendorff (1995), tries to extensively identify the contexts that co-produce meaning of an artefact. Reading his article for use quality, or different uses of artefacts reveals the following uses; social use, aesthetic use, symbolic use, and communicative use. Souttar (1998) analyses one of the holy cows of HCI, the icon laden graphical user-interfaces, with the help of four perspectives; functional, semantic, aesthetic and philosophical. Forlizzi & Ford (2000) describe their view of designing for experience. A story of use in their sense is told by the artefact through its form language, features, aesthetic qualities, accessibility and usefulness. This story is told in a context of use, with social and cultural factors in interaction with a user. Rosenman & Gero (1998) points towards three environments in which an individual resides, the natural environment, the socio-cultural environment and the techno-physical environment. They also defines the relationships between purpose function behaviour and structure, "*PURPOSE enabled by FUNCTION achieved by BEHAVIOUR exhibited by STRUCTURE*" (Rosenman & Gero 1998, p 167).

Finally, use quality is touched upon in a wide variety of sources, without explicitly focusing on that. Nevertheless, these sources have influenced my interpretation and position. Here will be mentioned a few, and hinted on their relevance and contribution. Philosophy of use

(Schön 1983, 1987, Molander 1996, McCullough 1998). Use/design theory (Monö 1997, Palmer & Dodson 1996, Bierut, Drenttel, Heller & Holland 1994, Coyne 1995). Use qualities and assessment (Nardi 1996, Friedman 1997, Mullet & Sano 1995, Lilienthal & Züllighoven 1997). Design/development process (Monö 1997, Kyng & Mathiassen 1997, Mullet & Sano 1995, McCullough 1998, Kristof & Satran 1995). While being part of my repertoire there are implicit and explicit references to them throughout the thesis.

Designing for quality-in-use

One position on use quality is proposed by Ehn and Löwgren. Ehn and Löwgren view their quality-in-use perspective as a joining element between HCI and informatics (Ehn & Löwgren 1996, 1997, Ehn 1995). Quality-in-use in their view is the combination of constructional qualities, ethical (or functional) qualities and aesthetical (or formal) qualities. The framework is lended from the Roman architect Vitruvius' framework strength, utility and grace.

Ehn (1995) interprets Vitruvius in a non-trivial way combining it with Habermas' concepts communicative action and knowledge interests.

> *The structure of a system is its material or medial aspects. /…/ The functional aspects of a system concerns its actual, contextual purpose and use. /…/ the form of a system expresses the experience of using the system.*
>
> Ehn & Löwgren 1997, p 21

The framework is meant to be used for evaluating and analysing the use of software, rather than the system as an object.

Ehn & Löwgren (1997) propose to evaluate quality-in-use from three perspectives (see FIGURE 7). First the constructional quality of a system in terms of correctness, performance, robustness, maintainability and portability. Secondly the ethical qualities of a system in terms of whether it is used in the right way. Third the aesthetical qualities of a system in terms

of an aesthetics. The three perspectives have to be dealt with in a holistic manner to successfully address qualities in use; "…*the integrated treatment of all three perspectives are needed for a proper understanding*…" (Ehn and Löwgren 1997, p 22).

Ehn and Löwgren (1997) point out two implications for system development of a quality-in-use perspective. First, they mention the emergence of information technology criticism. Second, they mention design ability as a central skill for a systems developer.

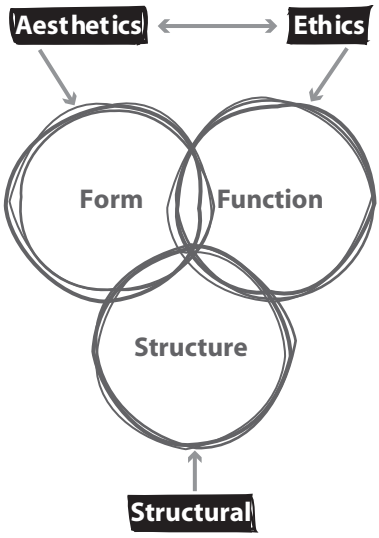


Figure 7. **A model of the artefact and quality-in-use, adopted from Ehn (Ehn** 1995**).**

It is fairly easy to sort any qualitative statement on an artefact both in Ehn and Löwgren's aspects as well as in Vitruvius'. They both lend their theories to that kind of distinctions, because what we deal with is seemingly a single artefact. But when using their theories in that way one is opening the arena for critique on several points. Four threads of critique will be presented here, critique of separating form from function, critique of the idea of a holistic quality perspective, critique of transferring architectural frameworks without referring to the differences in design material, critique of using Habermas unreflected.

Ehn and Löwgren avoids the inclusion of known critique against general doctrines, such as "form follows function", and other analytic categorizations in architecture and design, two fields upon which they heavily rely. This said not implying that it is possible or even desirable to transcend form and function. At the same time it is not possible or desirable to single out ethical quality from aesthetical quality, function from form. It is important to relate to the debates around this from the last century (see e.g. Lambert 1993). Discussions from the more mature fields of design would have been helpful in highlighting the irreducible tension

between the different aspects Ehn and Löwgren proposes. The different existing postures regarding whether "every function has to take on a form, as well as every form will be ascribed a function", have the power to introduce discussions on these matters from a common ground of known critique instead of opening a new arena for a repetition of the same or similar critique in a neighbouring domain. Asplund (1980) presents one such within architecture. The reluctance to include known debates from the originating domains, such as art, literature and architecture, might show to be more harmful than fruitful.

Another way of using Ehn and Löwgren's categories is to ask oneself; What kinds of constructional qualities is an implication of »help-strategies» for a word-processor? What kinds of constructional qualities is a prerequisite for us to use »help-strategies» for a word-processor? Finding a constructional quality, e.g. a support structure with a search facility and a degree of adaptivity and contextualization, one immediately needs to consider the aesthetical qualities of such a constructional claim. This brings forth a certain use of a system, which in term presupposes an artefact (or a cultural tool) and a user (or an agent). Interpreting the holistic view, as defined by Ehn and Löwgren, means that an evaluator always already has one perspective looking at the odd aspects; looking at formal aspects from the ethical perspective, constructional aspects from the aesthetic perspective and so on. The evaluator cannot have super view of quality-in-use; that would be another quality perspective. This misconception is not argued against in Ehn and Löwgren's notion of integration and holism. They therefore run the risk to imply such a transcending quality perspective. It is absolutely crucial that the three-part definition is not used as a way of separating the three perspectives from each other, but used as a means for highlighting different aspects of one and the same use, and one and the same qualities-in-use. Thus, the three aspects can be seen as a set of stances to take, and should not be regarded as a stipulative definition of exemptive categories.

Ehn and Löwgren's categorization also easily lends itself to criticism of not taking into account the differences of the originating domain and

the new application domain for the categories. The qualities of activity and dynamicity will be pointed out here. On a continuum from static to dynamic objects, architecture is by virtue closer to the static end than is system development. On another scale the use of architectural objects in most parts is passive, but in some parts interactive as well as pro-active, while the use of software, by definition, is interactive and pro-active, and only seldom passive. These differences in dynamics and activity cannot be disregarded (see FIGURE 8).

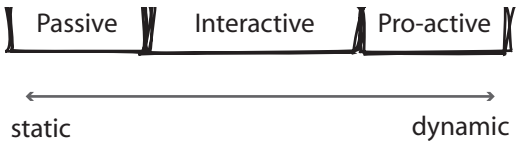


Figure 8. **The quality of activity and the quality of dynamicity**

It is not clear why we should choose an architectural framework as a model for interactive information systems. Furthermore it is not clear why we should choose the modernist accounts of architecture, with its heavy heritage from the Renaissance. All too often examples, be it for pedagogical or other reasons, are collected from the greatest modernists, e.g. Corbusier or Mies van der Rohe. These are not merely architects, they do handicraft, they are artists with an architectural expression. For example Asplund (1980) provides a thorough critical treatment of the modernist movement, which has ruled the Swedish architectural scene from the thirties until the seventies. We need to be able to clarify why architecture is a better model than the other design disciplines, than music, theatre and film-making, than joinery and happening/performance art. It might not be fair to make an analogy between film making and interaction design, even though the object of the design work is more similar, because of the differences between them giving a user/viewer possibilities to interfere with the ongoing telling of the story (neatly expressed through the user/viewer distinction). The uniqueness of the interactive material is its boundedness to time, the material has a time-dynamic form; interactions. The analogical assumption of using an

architectural framework for interaction design cannot be disregarded. The concern is not so much if it is wrong using an architectural framework, but if it is wrong trying to do so.

Introducing Habermas' notion of communicative rationality is not without problems. It assumes not only that communication free of disturbances is possible, but also that we wish to achieve that in order to reach our design goals.[2] Habermas notion is an idealistic model based on ideas of a conscious and rational subject, who strives for societal consensus through a public discourse. Other ideas to ground notions of communicative action upon would be a subject with limited autonomy (Kolb 1986), or a dynamic subject that plays different roles in different language games (Lyotard 1984). If one regards Ehn & Löwgren's model as an analytic framework, one must ask oneself who is participating in the analysis, for what purposes is the analysis made, who is the idealized subject, and what does it mean that one reaches consensus. That is, "who participates" is a definition of the public arena for the analytic discourse, "for what purpose" gives a partial limitation of the language game for the discourse, "the idealized subject" identifies the idealized individual behind the different quality perspectives and "what it means to reach consensus" defines the ending condition. Of course there are also combinations of these aspects that give rise to more complex matters, such as who participates for what purposes. Discourse in design situations, or about designed artefacts for that matter, will always be in parts non-rational, based on opinions, assuming power relationships, based on misunderstandings, led or driven by individuals, and be coloured and shaped by conflict and dissensus.[3] As a continuation of the Habermas based critique, one might also ask oneself, given that the model is built upon communicative rationality, if it also is a framework for intentionality. And thus if the perspectives corresponds to the material cause, the functioning cause, the formal cause and the final cause.

The main points made here is 1) that the analytic framework provided by Ehn and Löwgren carries a tradition which is not incorporated in its new environment and carries a metaphysics resting unreflected, which

2. This is also seen in design guidelines such as "Simple and natural dialogue" (Nielsen 1993), even though that specific guideline is not specifically based on Habermas.

3. I do not believe that this is bad, even though several of the words used have a bad ring to them.

needlessly diminishes the analytic strengths of the framework, and requires of its users to be familiar with that rich tradition. 2) that the integration of and holistic use of the qualitative perspectives is not thoroughly treated by Ehn and Löwgren, which does not focus the reader on the irreducible tension between the quality perspectives of the framework. 3) that the treatment of differences between the objects for design between architecture and IT-design and their prospective influence on qualities-in-use are not discussed, which unfortunately makes the framework questionable on ontological and epistemological grounds. 4) that it heavily relies on an idealistic framework for communication taken from Habermas, which unfortunately introduces doubts about its empirically and practical usefulness, as well as a dichotomization between an idealized subject and an artefact.

A revised framework for quality-in-use partly based on these points can be found in FIGURE 9. It detaches the quality perspectives from specific aspects of the artefact, and incorporates the frame within which the user utilizes the IT-artefact, such as a social, cultural or organisational frame. It is only by being engaged in a such that the perspectives will make sense to anyone.

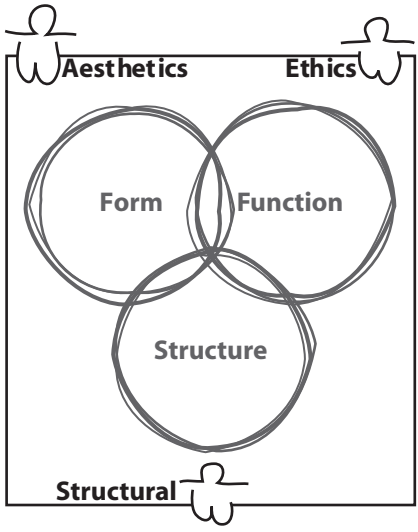


Figure 9. **A slightly enhanced model of qualities-in-use.**

Product semantics and use quality

Löwgren and Stolterman (1998a, 1998b) has developed a set of use qualities based on a fourfold model similar to the one introduced by Ehn (1995). In the introduction to their book (Löwgren & Stolterman 1998a) they talk about aesthetic, ethic, function and structure. In this sense they are premises for the rest of their writing, in the book as well as in the article (Löwgren & Stolterman 1998a, 1998b). They go on to define specific use qualities, as opposed to the four perspectives, through examination of several interactive artefacts. They identify social action space, tight coupling, transparency, interaction character, transformability, sym-

bolic value, dynamic Gestalt, autonomy, intrinsic motivation and playability as use qualities.

Even though Löwgren & Stolterman wants to introduce a more specific and genre-bound way of talking about use qualities, they assume frameworks such as Ehn & Löwgren's (1996), and Janlert and Stolterman's (1997). The obvious difference is that Löwgren & Stolterman speaks of actual interactive artefacts and the use qualities they identify involve users, artefacts as well as contextual, cultural and social aspects. In that sense they function as comprehensive descriptions of the character of using the artefact, and also as an interpretative framework for a product semantics.

Activity and artefacts-in-use

Turning to activity theory, the second notion of quality-in-use treated here (Bannon and Bødker, 1991), implies that we need to look at software and its qualities in the light of users operating information technology.

> *These operations, which allow us to build houses or do nursing without thinking consciously about each little step, are often transformed actions – that is, we conduct them consciously as actions in the beginning. Through learning we transform them into operations, but in encountering changed conditions, we may have to reflect on them consciously again, and thus make former operations once more into conscious actions.*
>
> Bannon & Bødker 1991, p 242

Thus the qualities that arise in use are manifested most often, and maybe most desirably, through operations, but also through conscious actions. These two disparate situations demand that we develop software that shows high quality in both. This implies that we might have to work with different sets of qualities for different situations, which both are prevalent at the same time. The most significant situation is when something »unexpected» happens. The user wants to get back into operating the system, and at the same time learn about that new situation and whether

that can be avoided, if it is a better way of operating the software, *et cetera*. The context in which the operation or the conscious action appears is an important aspect to investigate in pursuit of the qualities that matter in use.

> *Activity is what gives meaning to our actions, though actions have their own goals, and the same actions can appear in different activities.*
>
> Bannon & Bødker 1991, p 242

We might never understand that a piece of software is inefficient to use if we just look at the software out of its context. Exactly because the out-of-context user might not use it differently from the intention of the designers. The software has been thoroughly evaluated and developed toward this intention.

In order to be able to look through this we need to look at the praxis of the user, because that praxis is the main shaper of our way of seeing computer applications, as opposed to individualistic needs and understanding. We need to do more than just psychological analysis; integrating social relations, division of work, *et cetera* (Bannon & Bødker 1991). This puts evaluations of customer satisfaction and usability in quite a different light. It also provides the value-based definition of quality (Garvin 1984) with means of establishing and evaluating what is valued.

> *Artifacts, in a human activity framework, have a double character: they are objects in the world around us, which we can reflect on, and they mediate our interaction with the world, in which case they are not themselves objects of our activity in use.*
>
> Bannon & Bødker 1991, p 242

There is a risk, when focusing differences between practices as Bannon and Bødker does, to miss out on similarities between artefacts in different practices, and thus act conserving. But it puts forward the user in every

situation of use, and thus forces us to formulate a conception of the user both in general as well as in particular.

Bannon and Bødker also root their position in mediation and toolness. Quality-in-use in those cases easily ends up discussing break-downs and transparency.

Bannon and Bødker mentions the physical conditions, the handling conditions, and the operational conditions, as ways of focusing on how the computer application appears to its user in use. As with Ehn & Löwgren's quality-in-use concept, the mediated action consists of an irreducible tension between user and IT-artefact, which does not lend itself to transcendence through concepts such as praxis or activity.

Draft synthesis

To sum up the treatise, a draft synthesis of use quality will be presented. It is the view of use quality which I hold with all its limitations and biases. I have developed it over a period of five years as a deep study of theory of use quality, as a reflective practice in parallel with the empirical work, as a basis for developing and holding master's level HCI and interaction design courses, on my own and in collaboration with colleagues.

I will not go into any lengths on these different uses, or aspects from which one might look upon an interactive IT-artefact. I believe that if one excludes one of these, we no longer look upon the artefact as an interactive IT-artefact.

FUNCTIONAL. The functional perspective has to do with the purpose of the artefact and the functionality it provides.

ETHIC. The ethical perspective has to do with how people, based on an ethic, choose to use or refrain from using an artefact in specific ways.

AESTHETIC. The aesthetic perspective has to do with the aesthetics of the artefact.

POLITICAL. The political perspective has to do with how the artefact is used in a process of change or persuasion in order, e.g., to change the operations of a business.

TECHNICAL. The technical perspective has to do with how the artefact is constructed or how other technical artefacts can relate to the artefact.

SOCIAL. The social perspective has to do with how the artefact is used for social purposes. It is distinguished from political use mainly because political use is intentional, while social use does not have to be.

SYMBOLIC. The symbolic perspective has to do with how the artefact is used for symbolic purposes, or ascribes symbolic value.

PUBLIC. The public perspective has to do with how the artefact is used for public purposes, such as presentations, demonstrations, *et cetera*.

LEARNING. The learning perspective has to do with how users and teachers can use the artefact for learning purposes.

Depending on the situation in which these are discussed, used as descriptors, used as interpretations, you have it, who is participating in this activity, and for what purpose the activity is being performed (for deciding on a character before conceptual design, for producing a request for tenders, *et cetera*), what genre of interactive artefact is under scrutiny, *et cetera*, these different use qualities will change their role, their meaning and their importance. There will not be a super position from which one might say something about a general use quality, all statements always-already is situated in one or several of the above mentioned. Super positions might be taken by individuals participating, in the sense that they take command of the languaging done in the process of discourse, such as taking the problem formulating initiative, or keeping the preferential

right of interpretation. These discourses will be powered by conflicts and dissensus, and an inclusive mind set is necessary to balance the discourse and to avoid breakdowns, and stalling processes.

Compelling pictures are best made of this synthetic image when constructing models for specific purposes. Such as when presenting a software engineers working view for a specific artefact; s/he is in the middle of a special technical use of the artefact, its construction, a position in the life-cycle of the artefact with its own limitations, just as other positions present their own limitations.

SECTION III – OUT OF THIS WORLD

from 4' 33" by John Cage.

III.06

Empirical context

The researcher participated over a period of four years in two development projects. The first, explorative, in close collaboration with consultants, WM-data, and a bank, SPS. The second, intervening, in a collaboration with the same bank, after a fusion with another bank called FSB. In both projects the researcher's role was to act as a usability expert and a researcher.

Referring to the schematic picture presented in CHAPTER 03 this section deals with the boxed process and parts.

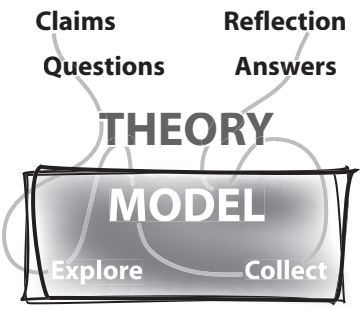


Figure 10. **Highlighting the focus of chapters 06 through 10.**

Using Word

Within the scope of the first project an explorative empirical investigation was performed. The consultants had developed a training program for Word users at the bank, and both parties were interested in knowing how the training could affect usability. The bank was performing a major change of platform, from a main-frame/terminal heavy environment into a Windows/network environment. A project group had

formed to define and assess the training programs developed, into which I was introduced as usability expert and researcher. The project manager was employed at the bank. While collecting material through contextual interviews and questionnaires, I tried to satisfy this knowledge interest and at the same time developing an understanding for use qualities. The expected contribution would be the tentative model, comparisons of pre and post learning assessments of usability and proposed use qualities, and proposals for use qualities. These were expressed in a tentative model, which was supposed to be used in later stages of the empirical work. See III.07 EXPLORING USE OF WORD.

Between projects

Between the projects two major changes took place. First, the consultancy could no longer internally motivate their participation in the research project, although the interest in its results was still high. Secondly, the bank, SPS, merged with another bank, FS, into the bank FSB. Continuity, with regard to the research process, was secured through the project manager from the bank, who continued being devoted to the research and development aims.

Using the teller system

Within the scope of the second project an intervention empirical investigation was performed. The system chosen for study was carefully selected. With the change into a Windows/network environment, a new general platform for bank applications was developed, GP2000. On this platform a basic sales support system had been developed, and part of that was the teller system, handling all cash transactions. When merging with FS there had been taken a decision to introduce the teller system from SPS at all local branches. So users of the teller system needed two kinds of training. The old SPS users needed to refresh their knowledge, and learn about the Windows specific ways of doing things, while the old

FS users were introduced to a totally new teller system, although cash transactions at the teller's desk of course was nothing new. So, we choose a central system for banking business, that was not a back office or support system, with a fair amount of users needing to learn the system but not the bank concept. Other systems that could have been scrutinized was a loan advisor system, the NT operating system, *et cetera*. These could not meet the criteria that the teller system would. The bank had developed a web based course for the teller system at the bank, and were interested in trying to increase the learning product's quality, especially with regard to how it contributed to the use quality of the teller system, to learn about use quality, as well as trying to design from a use quality perspective. A project group was formed, consisting during the first empirical steps of three learning developers and two usability experts/researchers, and during the last empirical step three system developers joined the team.

As a first step we utilized the tentative model from the explorative study and remodelled it together with the learning developers in order to reach an operationalised model fit for describing use qualities for the teller system. Together with the practitioners we chose a small set of use qualities that would be used to redesign the teller system course. The expected contribution would come from the modelling process, with several consecutive tentative models, resulting in one model used for the redesign of the teller system course. Other expected contributions would be the perspective put on use qualities by the learning developers, the possibilities of using a model developed for one kind of use as a basis for a model for another kind of use, the appropriateness of the concept to the learning developers, and experiences from using a model or parts of a model to do interaction design. See III.08 MODELLING TELLER SYSTEM USE, THE FIRST ROUND.

As a second step we collected field data from users who had followed the redesigned training program. We visited them before and after training, trying to understand their use of the teller system in their daily work. The field data was again modelled by the researchers. The expected con-

tribution would be a focused study of the chosen use qualities for the redesign of the teller system course, the use qualities identified as well as the model/s created. See III.09 TELLER SYSTEM USE.

As a third step the larger team modelled the field data. The expected contribution would be the different perspectives put on the material by the different group members (learning developers and system developers), the appropriateness of using field data in a group like this to model use qualities, the reiteration of earlier model/s, and the new model/s produced. See III.10 ASSESSING TELLER SYSTEM USE, THE SECOND ROUND.

Notes on reading this section

The section is divided into four chapters, corresponding to the four different empirical investigations performed. Quantitative material has been included where appropriate.

Every work of art can be evaluated, in part, as ratio between that which is intended by the artist and not expressed in the work, and that which is unintentionally expressed by the work

Marcel Duchamp from The Interactive Art Gambit ("Do not run! We are your friends!") by Ken Feingold

III.07

Exploring use of Word

This chapter describes an explorative empirical study. It is the first in a consecutive row of studies shifting between studying use and modelling use.

Setting

The project was a joint effort with WM-data and Sparbanken, SPS (before the fusion with Föreningsbanken, after which they were called FöreningsSparbanken, FSB). WM-data designed and gave a Windows family training course for the employees at the SPS-bank, with the goal that the employees of the bank would be able to get a ECDL, a PCdrivers license promoted by the EEC.

The IT-environment had been heavily dominated by terminals, both at the counter and for most back-office functions. A few years earlier there had been a cut-down of the centrally administered documents, in favour of an electronic billboard system. Now the bank was about to change the user environment into a PC-based environment, a platform called GP2000. To ensure a consistent lowest level of competence, the ECDL was included in the introduction of the GP2000.

The idea was that the users should first of all get a PC to use at home, and then later get a PC at their desk. Some of the users in the study did not use their PC at home, partly because it was too hard to install. When the PC arrived at their desks

only parts of the applications that had been planned to be provided within GP2000 at that time were up and running.

WM-data designed and produced a traditional course as well as a CD-ROM based training program, among which the users could choose what they felt suited them best.

It was decided that among the different courses in the course package the project's efforts would be focused on the Word training.

Purpose, character and role

The research purpose in the project was to explore and modify the existing description of usability as a model of use qualities. The practitioners goal was to gather experiences about evaluating the effects of the course through assessments of use quality.

Methodological issues

The users participating as informants in the explorative study were all part of the same traditional course group, and had some experience of PC-use, so the shift in technology would not be the main effect on the use qualities.

To be able to study changes as well as explore variance in the use qualities a pre/post design was performed. The study performed before training occured the week before the course started, and the study performed after training occured approximately six months after the course ended. Eight users participated in the use study, seven of which answered the questionnaire.

Choice of qualities under study

In order to explore use qualities in the light of the course there was a need to combine the theoretical framework with the actual goals of the course. Documents from the instruction design, discussions with the instructional designers, company information about the training as well as dis-

cussions with the people responsible at the Bank was used to specify the use qualities of interest for this specific project.

From the theory framework (cf. SECTION II) and the specific project eleven use qualities were identified and selected for investigation.

COMPUTER SELF-EFFICACY. Computer self-efficacy comes from Bandura, and means how confident a user is to achieve a certain goal by using a computer. (e.g. Busch 1994, Harrison & Rainer 1992, Compeau & Higgins 1995)

RELEVANCE OF USE. This was one of the goals stated for the course (for GP2000 a similar goal was formulated). The users should experience the use of Word as being relevant to their work (Löwgren 1993)

EFFICIENT TASK. This was another goal stated for the course. The users should be able to solve their tasks within a short period of time. (for GP2000 a similar goal was formulated) Similar goals are found in most usability oriented evaluation methods (e.g. PSSUQ (Lewis 1995), SUMI (Porteous, Kirakowski & Corbett 1993), Löwgren 1993, Trumbly, Arnett & Martin 1993)

PROBLEM-FREE TASK. This was another goal stated for the course. The users should be able to solve their tasks with few problems or errors. Similar goals are found in most usabiltiy oriented evaluation methods, (PSSUQ (Lewis 1995), SUMI (Porteous, Kirakowski & Corbett 1993), Nielsen & Molich 1990)

CORRECT TASK. This was another goal stated for the course. The users should be able to solve their tasks producing a correct result. (for GP2000 a similar goal was formulated)

MOTIVATION TO USE. The course should increase the user's will to use Word in their work. (for GP2000 a similar goal was formulated) (Sein *et al* 1987, Allwood 1991, Bostrom *et al* 1990, Olfman & Bostrom 1991)

MOTIVATION TO USE FOR MORE QUALIFIED TASKS. The course should also motivate them to use it for more qualified tasks (course goal). (for GP2000 a similar goal was formulated)

THE TIME SPENT IS WELL SPENT TIME. The time in front of the computer should be experienced as well spent (course goal). (for GP2000 a similar goal was formulated)

THE TIME SPENT WITH CUSTOMERS IS QUALITATIVELY BETTER. The time spent with customers should be experienced as having higher quality (course goal). (for GP2000 a similar goal was formulated)

PERCEIVED SAFE USE. The user should feel confident using the system (course goal).

PERCEIVED SHORTCOMINGS. The system should not be experienced as one having a lot of shortcomings, or serious such (course goal).

What we primarily expected was that computer self-efficacy were to behave in a similar manner as we saw subjectively perceived usability do in the pre-study, FRAMING A PARADOX in 1.02. That is, we expected a corroboration.

The other use qualities were more or less under exploratory scrutiny.

Conducting

Data collection

Two data collection methods were used in the pre-study as well as in the post-study. The main qualitative part was collected in a use study, through observations. During the use study the users were asked to answer a questionnaire, mainly intended to be used as a probe for analysis of the qualitative material.

Use study

I took part in the user's work approximately one half day per user, taking notes, asking questions, trying to uncover use qualities. The use study was transcribed, and then sent to the informant, who in turn commented on the protocol. A follow-up telephone interview was performed to clear out mistakes, misunderstandings and to provide with answers to follow-up questions, from me as well as the informant. The new protocol was sent to the participant in order for them to provide comments or agree that the protocol according to them was a good description of that particular half-day at their work.

Questionnaire

For the construction of the questionnaire (see APPENDIX 1) experiences from Holmlid (1995a) was used, as well as influences from PSSUQ (Lewis 1995), SUMI (Porteous, Kirakowski & Corbett 1993), ISO *et cetera*. The main purpose of the questionnaire was to guide the explorations into the qualitative material, therefore the rigour in questionnaire design was less than would be expected from a questionnaire to be used as the sole empirical material to be investigated.

For the measurement of computer self-efficiacy the questionnaire from Compeau och Higgins (1995) was translated into Swedish before use. As a pilot the first version of the questionnaire was distributed to three colleagues at the department, one of which bilingual, who com-

mented on the questionnaire. The questionnaire was rewritten, and once again distributed to the three colleagues.

For the measurement of the other qualities several sources were used (PSSUQ (Lewis 1995), SUMI (Porteous, Kirakowski & Corbett 1993), Martocchio & Dulebon 1994). Questions from all these sources were collected and grouped, and a smaller set of questions were used for the questionnaire. Apart from computer self-efficacy, questions referring to one quality were as far as possible not placed as a group on the questionnaire. In total the questionnaire finally consisted of 35 questions, 10 for computer self-efficacy and 25 for use qualities, all fitted onto one sheet of A4 paper.

For each statement a Lickert-scale was used to enable the users to indicate whether they disagreed or agreed to that specific statement; for self-efficacy a ten point scale, and for use qualities a six point scale. Similar to the CSE questionnaire used (Compeau och Higgins 1995) all factors were coded in terms of their strength and their magnitude. The strength was calculated as the sum of the answers given for a specific quality. The magnitude was calculated as the number of positive answers.

Descriptive statistics

As there were only seven participants answering the questionnaire descriptive statistics will be presented promptly, and then the discussion will take over. The statistics given will provide the reader with a possibility to assess the plausibility of the analyses in the next section. The singular use qualities studied will not be presented here, other than when needed for the discussion, although the total use quality factor will. The full set of descriptive statistics is provided in APPENDIX 2.

The presentation of statistics for computer self efficacy follows Compeau & Higgins (1995). The median is given as the prototypical value, the mean as a means for understanding skewedness, the magnitude is a measure of how many questions were answered with a "yes", and the strength how strongly the informants agree, i.e. the sum of the ratings.

BEFORE THE TRAINING PERIOD. The informants answered the questionnaire the week before the training period. In TABLE 3 the data for computer self efficacy collected before the training period is reported. In TABLE 4 the data for use quality collected before the training period is presented.

Table 3: **Computer self efficacy before the training period**

Self efficacy	Median	Average	Magnitude	Strength
AR	7,00	6,40	9	64
YH	4,00	4,40	8	44
SS	7,50	7,70	10	77
MS	10,00	9,40	10	94
YY	6,50	5,20	9	52
JL	8,00	7,20	10	72
GS	5,00	4,20	10	42
GROUP	7,00	6,36	66	445

Table 4: **Use quality before the training period**

Use quality	Median	Mean	Sum
AR	2,00	2,92	73,00
YH	3,00	3,32	83,00
SS	2,00	2,96	74,00
MS	3,00	3,20	80,00
YY	2,00	3,04	76,00
JL	2,00	3,12	78,00
GS	4,00	4,00	100,00
GROUP	3,00	3,22	564

AFTER THE TRAINING PERIOD. The informants answered the questionnaire approximately six months after the training period ended. In TABLE 5 the data for computer self efficacy collected after the training period is reported. In TABLE 6 the data for use quality collected after the training period is presented.

Table 5: **Computer self efficacy after the training period**

Self efficacy	Median	Average	Magnitude	Strength
AR	9	8,2	10	82
YH	8	7,6	10	76
SS	9	8,9	10	89
MS	9,5	9,2	10	92
YY	7,5	7	10	70
JL	7	6,9	10	69
GS	6,5	6	9	60
GROUP	8	7,69	9	538

Table 6: **Use quality after the training period**

Use quality	Median	Mean	Sum
AR	1,00	2,64	66,00
YH	2,00	3,12	78,00
SS	2,00	2,88	72,00
MS	3,00	3,40	85,00
YY	3,00	2,76	69,00
JL	2,00	3,04	76,00
GS	4,00	3,76	94,00
GROUP	3,00	3,09	540

Analysis and interpretation

The first four paragraphs will be used for the interpretation of the quantitative material. The first two of these are straightforward analyses, the second building on the first. The last two paragraphs are interpretations. On PAGE 109 cont. the qualitative material will be analyzed and inter-

preted. In APPENDIX 3 the citations from the qualitative material is collected.

Failure to corroborate use quality increase

Just as in the paradoxical case in 1.02 there is no positive development in the subjective rating of use quality. With a classical usability perspective, with its learnability concept, an increase would have been expected, given that the users in fact try to learn to use Word over the six month learning period. Within such an interpretative framework the learnability, given this context and these users, of Word would have been negative, or even that the learning period had no learning effects.

From a pedagogical perspective, though, it would be impossible to point towards such implications. Partly because the influential factors, such as the change of contextual factors, are hard to control in studies of effects of learning. And partly because there is no evidence whatsoever that usability or use quality are meaningful measures of learning.

For the purpose of the investigation presented here, however, it suffices to notice that the learning period and the learning process provide us with factors having some influence on the measure of use. With a use quality perspective the failure to corroborate any hypothesis of the effects of learning on measures of use, will serve as a basis for reformulation of what constitutes aspects of use quality pertaining to the learning to use a piece of software.

Given that it is hard to show that usability increases when people learn to use the products, and given that they in fact become more proficient using the products, we have to draw the conclusion that it is highly questionnable to connect a learnability quality of a product to the increase in usability. A products learnability need to be related to the work which it is supposed to support, and not to abstract measures of usability (Efficiency, Effectiveness, Satisfaction). Use quality and usability, as expressed in this chapter, are no reliable measures of learning, they are merely snapshot views of a complex web of dependencies, which are not

readily catched even with the familiar notion of context, mainly because of its passive and static formulation.

The influence of self-efficacy

Looking only at use quality would force us to conclude that the learning period as a whole did not succeed in increasing the use quality. The Wilcoxon signed rank test for the use quality factor shows a significant difference (W=3, N=7, p<0,05), a decrease, between evaluations.

The computer self-efficacy measure gives a partial explanation. There is a significant interaction between the two factors computer self-efficacy and use quality (ANOVA, F(1,8)=8,61, p<0,019) for users scoring low (less than 64, which is the median score) in the pre assessment, see FIGURE 11.

Even though the users from the beginning were not novices, there seem to be a kind of »*low-achiever*» group which complicates the picture. The weakness of usability vis-a-vis novices, as seen in 1.02, is transformed into a weakness of the use quality construct *vis à vis* low-confident users.

The danger with the difference between the *low-achiever* and the *high-achiever* becomes evident when looking at FIGURE 12. Here users are

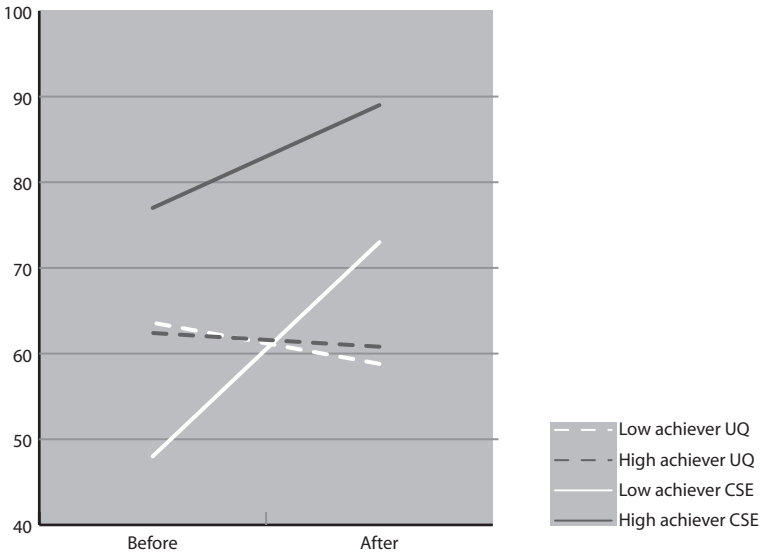


Figure 11. **Use quality and computer self-efficacy interacts for users with a CSE measure of 64 or less before training**

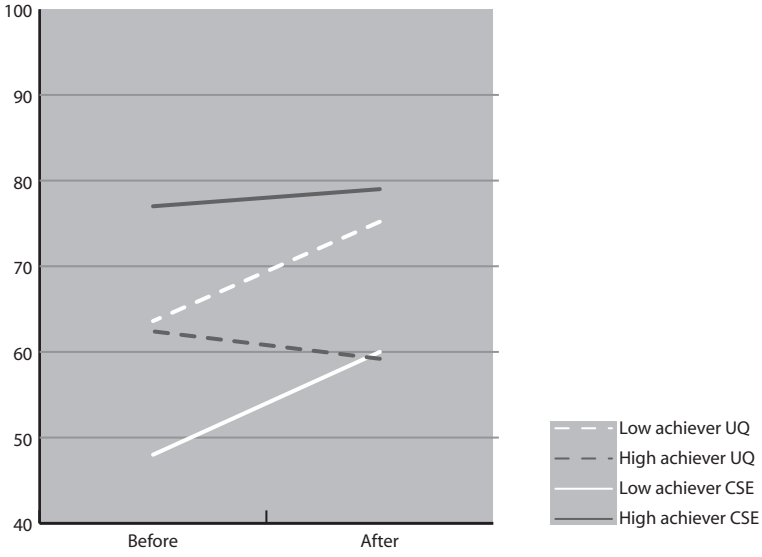


Figure 12. **Use quality and computer self-efficacy differences between before and after assessment (high achievers scoring higher than 64 on CSE)**

grouped into a low and a high achiever group looking at the two assessment occasions as "different" groups, which is the most common way when assessing usability across competence groups. Without looking at the specific values it is obvious that the difference between the two ways of looking at the data provide different sets of conclusions about a system's use quality, and how it changes over time.

Self-efficacy and training influence ratings of use quality as well as usability, especially for low-achievers. This makes it more difficult to evaluate usability of a piece of software across groups of competence and confidence. With novice or low-confident users usability and changes in usability might even be over-rated.

The novice case is well established as a design consideration, while low-confident users yet is not, although Kirakowski & Corbett more than a decade ago pointed out the importance of self-efficacy (Kirakowski and Corbett 1990).

To get an accurate picture of the usability of a product we need to know the level of efficacy and training received. Self-efficacy seems to influence subjective ratings of use quality. The effect supposedly is different between users with a high computer self-efficacy and those with a low computer self-efficacy and over learning periods.

It is hard to define a traditional usability criterion that relates closely to computer self-efficacy. However, use qualities where confidence is an important aspect can be formulated.

These two findings will now be put in an interpretive perspective.

The idea of the value-added

One possible reason for the interaction of the *low-achievers* could be the source of their use quality rating. With a low confidence, in the beginning of a change process, the conception of the value-added the software will bring will be based more on the internal marketing of the software than on your own experience. When the piece of software is put to use during the learning process, the user gains a more realistic idea of what the software can do. It does not mean that the piece of software is less usable for the low-achiever, only that s/he has a more realistic view of its role in his/her work.

Yet another interpretation would be that they have got this wonderful idea of what the software is supposed to be able to do for them, but they are not that confident that they can achieve that with the software. After the learning process they realize that the picture they had was exaggerated and that to the extent that the software is a useful tool to them they are confident using it.

Low-achievers show an extra-certain use quality before training and a (more) certain after training. They also drastically change the ratio between computer self-efficacy and use quality.

The high-achievers have a fairly stable certain quality, maybe independent of their computer self-efficacy.

The mix between user's own judgment and what they have been told is important to assess. Low computer self-efficacy users will trust what others say, while high computer self-efficacy users are confident enough to trust themselves. The effect supposedly differs between different levels of computer self-efficacy and computer experience, and with how the internal marketing is carried out.

Usability focuses on the product as a constructed artefact, and does not easily integrate management information about the product within a specific context, as a factor. Neither is the mixed-conception easily integrated. With a use quality perspective these factors can make a difference.

A reflection on useful *vs*. usable

For the low-achievers the piece of software promised to be usable, but turned out to be useful. They learned that the software, although being more efficient after training, did not bring the added-value to the customer as easily. Had we tried to find out what would make the software useful to the individual user, the questionable learnability could have been avoided.

Usability measures need to be based on usefulness for the purpose of studying learnability and changes of use quality or usability over time.

After this walk through of the quantitative material, the attention is turned towards the qualitative material. Two main concepts were identified, which are subsequently presented.

What precedes use

From the qualitative material a complex category rose, with some linkage to the quantitative material. In many field notes one will find entries expressing an »ante-use», such as in

> *YH takes a telephone call. Takes notes on a post-it . The telephone call is about taking over a loan from another bank.* [1]

In most cases they would pass as preparations, or problems with technology integration, or a user preference. The interesting question is not

to ask oneself what he is preparing, but why he is preparing (those things). He is preparing because he has an expectation (and knowledge) of what will or may be needed in use later on to achieve his goal. The technocentric answer to the same question, that the machine isn't fast enough or isn't voice controlled, is of minor interest. In the technocentric arena, unless we merge with our computers, there will always be something that precedes use, which is based on expectations on and knowledge of/about future use.

> *A lot of things can be solved over the phone, especially the collection of facts.* [2]

Another side to the preparations theme is to plan when to use a specific software, or not to plan:

> *It is possible for X to run Windows and Application B at the same time, but has to reboot to be able to use Application A. "Then one should plan things. But when it feels cumbersome, you just don't do that."* [3]

In the name of being efficient at work, and all too well knowing about how much time and effort it takes to reboot, he wants to plan the use of the different applications, so he does not have to reboot the computer several times a day. As an example this is very appalling, and drastic, but in its more subtle senses the planning theme occurs over and over again. How long time does it take to start an application several times a day; or put in a hardware perspective – how much memory and process speed is needed not to notice whether an application starts or has been running all the time?

Yet another part of the preparations theme has to do with the customer being prepared. In this study the clearest example of someone being prepared for doing banking business was a customer marching in with a newspaper clip as a basis for discussions.

However, »ante-use» seem to be more complex than that. It is also about expectations of use, actual, future or imagined.

She does not use the Help a lot. "I don't have time. And by the way what's written there is often lame." [4]

This is what she states when working with me as her trainee. A split second later she decides to open the help function.

She starts the help function... "Well, as a matter of fact it is not I see now". [5]

She had this idea of what to expect from the help function, based on earlier use or what others told her. The surprise with which she realised that the help actually can help was impossible to catch in the protocol. This "idea of what to expect" goes beyond the traditional mental model conceptions. Sometimes it seems to be a kind of genre established limitations; many producers does not try to do anything else than what she expected from the beginning.

Even when you want to do something out of the ordinary or something related to the ordinary but with some kind of special purpose you go by your expectations.

X has got a case on his desk which involves to call in and pay off a prematured loan, and the computer supported process does not do the trick correctly (the customer should not pay the compensation for interest-rate difference), and the manual form available is not suited for doing the job. [6]

The ordinary procedures does not suffice, only because it is impossible not to send an invoice for the compensation for interest-rate difference. The expectations lead wrong.

So X is looking for help from a colleague. X & C come in with an instruction for how to do it. C reads the instructions and X performs the actions. For every action X comments "But it is a loan contract" "It jumps over that part" "It's a renewal". When all actions are performed there is a print out, which is correct, and all the extras needed for this specific transaction were available. The printout routine was hidden under "Ordering a promissory note", which this wasn't (they wanted to pay off a prematured loan). [7]

Contrary to expectations they were supposed to start out as if they were to subscribe to a loan. X comments out of his preconception of what they were supposed to do, while C told him what steps to take for this special case (a general offer to pay off a prematured loan and renew the loan at a lower interest rate, which means that there were a lot of loans to do this for).

As such, for them the instructions how to perform the task acts as a ante-use; someone has used this before and documented how to do it regardless of expectations.

Knowledge of a future use also precedes use. The following two examples report on failures, i.e. there was a lack of knowledge.

The notes on the paper from an earlier phone call does not suffice. G thought that she had done an account, but there is nothing for that customer. [8]

She knew she needed an account to be able to perform certain things for the specific customer. She remembered the talk as one where she also made an account. With the notes she had after the conversation she could not make a new account.

It is problematic that you do not know where to find a specific screen, a chain of screens etc. This is what a clerk should be good at. Not to have to search, to know where to find. [9]

This clerk is in fact speaking about professionalism and the use of technology. He believes that one main competence of a clerk is to know how to utilize the computer tool they are provided with. Today, though, he does not feel that this is the case.

In the extension of this there is the classical divide between knowledge in the head and knowledge in the hands, as well as where the responsibility for knowing things should be; at the computer or with the clerk. In the following example the clerk make it absolutely clear that he is the one with the expert knowledge, he will be responsible for the calculations made, and that it is important to engage with the tool as well as the material to be able to do that.

"It is good to do things by hand. If it was done automatically, there's a risk you wouldn't be as meticulous. You got to have a feel for certain things, which means you need to work with them" [10]

Another more far-reaching example touches on the installed base, or the investment made in earlier use. It links the use today to similar uses, in this case regular such, years ahead.

"We must se the same ground for our calculations every year. Otherwise it becomes very complicated to go back all those years to present new comparisons on new basis." [11]

It is also quite obvious that ante-use is not limited in time. The traditional use or usability perspective limits a task to a specific time frame. But ante-use introduces the possibility of analysis of use where there is no specific point in time where you can objectively say that the use starts. You may agree on a time frame within which activities of sufficient interest lies. Still, there is no exact starting point, only a continous shift between use and ante-use.

AL saves the protocol. She writes down the file name for later reference on the note she used before to write down the civic registration number. [12]

Surprise and confusion

This pair of use qualities first entered the analysis through Holmlid (1997c), and then was developed further in Holmlid (1998). The analysis made here takes these at its starting point, and tries to isolate to the empirical material from the study performed here.

AS is writing a protocol. She formats with the toolbar while she is writing. She adds a tab with the ruler "I learned that at the course" The tab is a center tab. AS continues to write. Discovers the faulty tab, tries another one "I'll do like this". Tries to change the tab kind. Continues to write. Still a wrong tab. Messes about with tabs, margins, insets etc. Finds the Undo-list by mistake.

"This is good!" Undos most of what she's done and starts to write anew. [16]

AS is confused at first. She learned how to do tabs at the course, but clearly does not remember it too well. So she changes use strategy and explores other ways of getting it the way she wants. This is most commonly called trial-and-error, but here the term exploration will be used. Then she finds the undo-list and is surprised. All the problems and solutions are related to her actions and not at all with the content of her work. She has a goal to achieve, but does not have the manual skills to perform that.

"698 difference... if I make this positive... What? .. Why doesn't it react to that... Right, Closing balance... Diffference to what...Oh yes, it's this one I need, now I get it." [13]

This example is a contrast to the previous. Here it is the contents, or framework, of his work that is the root cause for confusions. Or rather how the Excel-template he uses for calculations performs with regard to his expectations on how to perform his tasks. In this case he is doing the same kind of task every month, and it is important that the result is correct. Differences not accounted for are downright bad, and need to be cleared out, solved or explainable before the work is done. So he is first of all confused that there is a difference at all, and tries out a solution. Which does not work. So he explores some more, trying to understand the calculation conceptually. Then is surprised when he finds the "one I need".

It is problematic that you do not know where to find a specific screen, a chain of screens etc. This is what a clerk should be good at. Not to have to search, to know where to find. [9]

In this example the clerk is reflecting on the vast structure and functionality provided by the systems they use. What he also is saying is that a clerk should not spend their time with the customer exploring the system to find out how to do things; i.e. not to act confused.

An example of a case where there is a large amount of exploration, fortunately without a customer at the desk, is the following:

X has got a case on his desk which involves to call in and pay off a prematured loan, and the computer supported process does not do the trick correctly (the customer should not pay the compensation for interest-rate difference), and the manual form available is not suited for doing the job. [6]

So X is looking for help from a colleague. X & C come in with an instruction for how to do it. C reads the instructions and X performs the actions. For every action X comments "But it is a loan contract" "It jumps over that part" "It's a renewal". When all actions are performed there is a print out, which is correct, and all the extras needed for this specific transaction were available. The printout routine was hidden under "Ordering a promissory note", which this wasn't (they wanted to pay off a prematured loan). [7]

X is confused that the instructions lead them another way than the ordinary (subscribing to a loan instead of paying off a debt), surprised that a part of the loan contract is skipped automatically. Before this episode X had been trying to find out how to pay off this specific loan in several other ways, such as with a form.

The ratio of what unexpected things the audience does when they become participants, and which expected things they do not do at all

from The Interactive Art Gambit ("Do not run! We are your friends!") by Ken Feingold

III.08

Modelling teller system use, the first round

This chapter describes the transformation of the tentative model from the explorative study into a practitioner appropriate model, as well as the priorities set for the redesign of the teller system course.

Setting

The project started out as a direct continuation of the project in III.07. Along the way, project realities and the participating organizations changed.

The project was an effort of FSB-bank. Within the new general platform a new teller system was developed. After the fusion between the two banks the users had experience from two different teller systems. The newly developed was based on one of them and took all codes and short-cuts from that. There was a need to develop a course that both gave the experienced users an introduction to the new way of working, as well as giving the inexperienced users a possibility to learn the teller system.

A course had been developed earlier, highly modularized so as to give the user the opportunity and possibility to choose what s/he wanted to learn.

By now the research perspective was driven by two research colleagues with similar interests, enabling a higher degree of involvement and participation without losing the stability of data collection.

A project group was formed, led by the same project leader as before, with the two researchers, the bank employee who had developed the content of the existing web based course, and the developer who had took care of the implementation of the course.

Purpose, character and role

The purpose of this study was to discern whether the education designers could and would make sense of the use qualities developed during the first aspect. The means of performing that kind of modelling was to redesign a learning environment on the basis of their understanding and prioritization.

Methodological issues

The development work was performed in a workshop format. The strength of workshops is that they are limited in time and space, and give several individuals the opportunity to participate in all activities encompassed by the workshop. The weakness is that participants need to bring all ideas and activities to a specific occasion during which they might not be at their best, and all the traditional group aspects, such as group think, formation of oppositions within groups, *et cetera*.

Although being active participants in the design group the researchers were acting as usability experts and interaction designers, whereas the training professionals acted as training experts and bank experts.

Conducting

Data collection

Experiences were collected in a workshop format. Basically two kinds of workshops were performed, use quality workshops and design workshops. Over the 13 months this process lasted a total of 14 workshops were held, of which 7 were use quality workshops. The two kinds of workshops were not clearly distinguished for the project group, and the main difference between them were that during design workshops the goal was to create and evaluate design concepts, whereas the use quality workshops was aimed at formulating and prioritizing use qualities.

Use quality workshops

These workshops were led by one researcher and circled around transcripts from use studies, and the charting out of use qualities done from these and from readings. The project group discussed relationships between different qualities, as well as what the different use qualities meant, and whether the individual use qualities could qualify for directing design of a course material for the teller system. The project participants were encouraged to identify and link use qualities, based on the material or on their own experience.

The goal for the last workshop was to identify a few qualities that could be used as a design base for the on-line course material that was to be developed.

Design workshops

These workshops were led by one researcher that acted as designer and circled around design concepts based on the use qualities chosen in the use qualities workshops.

Analysis and interpretation

The analysis and interpretation given here is mine, where nothing else is stated explicitly.

Collecting use qualities

Possible use qualities were collected from several different sources. The resulting large number of possible qualities forced the project group to focus on those qualities that seemed to be most central.

The original use qualities were developed for a Word-course, we first decided to work on an NT-course, but for project reasons shifted to the teller system course. In this process a wide array of use qualities was identified, from which we chose a small set. This non deliberate explorative process colours the interpretation, with a high degree of initial divergence.

A large part of the material were put together in a box diagram (see the sections on modelling). The individual parts were grouped and linked together in a way supported by empirical material as well as readings.

The abstract model

The first preliminary model constructed consisted of four parts; System, Task, Organisation and User (see FIGURE 13). They were supposed to be used as a definition space for any kind of use, be it a learning use or a productive use of a technology. The model was generated through an abstraction process from several other models (Martocchio & Dulebohn 1994, Sein, Bostrom & Olfman 1987, Cotterman & Kumar 1989, Bostrom, Olfman & Sein 1990, Busch 1994, Olfman & Bostrom 1991).

Figure 13. **Depicting use in an abstract model**

The idea was that a productive use or a learning use would be different ways of utilizing the same resources in the model. A strength of such a model is that the four areas are clearly inseparable. Any kind of development could be described within the same framework. So, if one needs to train our users in using technology in order to perform their tasks with higher accuracy within the given organisation, we focus on those issues; but it makes it possible to evaluate whether it would be a better idea to change the organisation in order to provide the users with an environment where they are able to perform their tasks with the given technology at a higher accuracy. So besides being a static model, it provides the means of defining a development in step-wise changes. What is not clear in this model is that organisation and task together structure the relationship between the user and the system, i.e constrains and creates possibilities.

The project group identified two weaknesses. First, productive use and learning use are not divided in time and space. Sometimes they are, but this is a matter of organisation or task structuring, not something relating to the two kinds of uses. As a user you switch, consciously or unconsciously, back and forth between production and learning all the time. It is even questionable whether there is a clear distinction between the two. Second, the practitioners immediately discarded the model as too general to be workable.

The detailed model

The second tentative model used was based on specific items found in earlier modelling material, in material where goals for the introduction of the new systems were stated, *et cetera*. They were collected and reviewed during use quality workshops. These 46 items were in turn structured and related to each other into the categories Computer Self-Efficacy, Motivation, Work, Knowledge, Customer, Software, and Course.

The practitioners felt this structured model to be more useful, and it was used as a basis for the continuing activities. It was directly based on

the Word-case, which was felt to be constraining, in the sense that we were focusing on NT knowledge for the next step.

The more detailed model

The third tentative model used was based on specific items found in earlier material, in course planning material, in material where goals for the introduction of the new systems were stated. All in all 45 such items were identified and reviewed during use quality workshops, some examples are; Eradicate fear for tools, Openness, Strengthened self-efficacy, Manual skills, Responsibility for learning, Less problems. These were in turn structured and related to each other into the categories Individual differences, Organisation, Work, Knowledge, Customer, and Learning.

The practitioners felt this structured model to be really useful, and it was used to prioritize between the different qualities. Fifteen items were identified as primary in relationship to the course goals. None of these were under the headings Customer and Learning.

Project realities had us change focus at this specific point in time. Instead of focusing on NT-knowledge we were focusing on using the teller system as a case.

The really detailed model

The fourth tentative model used was based on the earlier modelling work, but also on a workshop where we tried to find issues and define the goals of using the new teller system. The result was a very detailed model, 97 items structured without headings. This in turn was used in a workshop to define a structure and formulate more general use qualities. The resulting structure consisted of 4 categories comprising 30 items.

Putting the model together

The fifth tentative model used was the outcome from the fourth model and its structuring. The structure was formulated as different kinds of aspects of the use of the teller system. The resulting structure consisted of 12 categories comprising 74 items. Especially one of the designs from

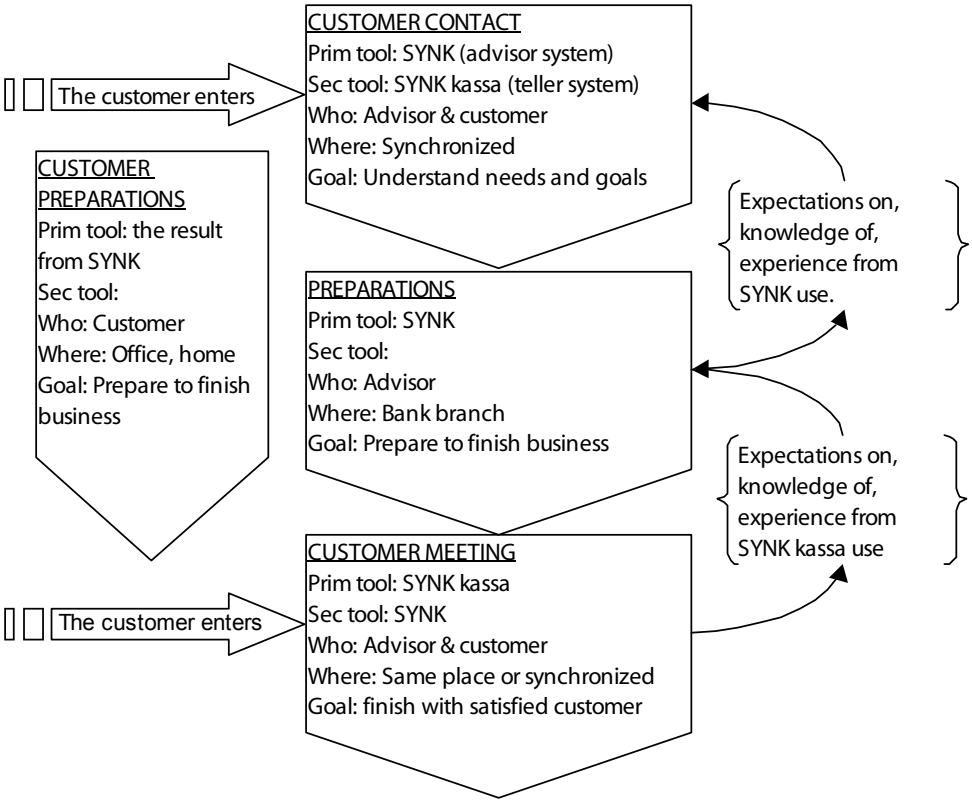


Figure 14. **A model describing the different situations of use for the teller system.**

the model became central for the project group. It described some of the different uses to which the teller system is put when used in connection to a customer (see FIGURE 14). In this model ante-use became an integral part of the model of teller system use at the bank. All the uses identified explicitly and implicitly stated in the figure was; The tool use, the ante-use, the mediating use, the business effects of use, the use of a portfolio of tools, the effective use, the use from the customer perspective, the customer's use.

Choosing design priorities

During one workshop the practitioners were asked to single out the use qualities of most interest or importance for the design of the Web-based course. They chose ante-use, tool integration, and bank-customer relationship.

After presenting the modelling process the attention is turned to its interpretation and results.

Transferring use qualities between application domains

The input to the process was use qualities generated for another application; Word. At first one would think that it would be hard to use them for the teller system course material design. In the discussions with the course developers it became apparent that the use qualities generated were more related to the use of IT at a bank, than being specific for Word. Of course some use qualities were not of interest.

The use qualities collected for Word use originated from back-office bank work, which led to a restructuring of the use qualities when used for the teller system use by advisors and tellers. These changes were mainly related to the production orientation of the teller system and the larger degree of customer contacts that the tellers and advisors have.

Synthesizing different uses of the teller

As a result of the workshops a process related model of the different uses took shape (cf. FIGURE 14). At a quick glance the model seems fairly simple and intuitive. But it introduces two important aspects of use; the preparations of the customer (left hand side), and the *à priori* expectations (right hand side). As such the model is not a process model, i.e. the expectations side is not a feedback loop, but rather an indication that you need to know how to use the tools to close a deal in order to use the tools appropriately earlier, and make the best of preparations and have the cus-

tomer make their preparations well. If one does not know that things done before the closing of the deal might decrease efficiency, or whatever other quality, is important in later stages of use.

The model might also look oversimplified. Anyone who knows what it is like to work at a bank knows that the process is much more complex than that. For every spot in the model there are perspectives that might be taken, which makes the picture more complex.

Designing a course from use qualities of the application

The choice of qualities resulted in changes in structure, content as well as teaching methods for the course.

ANTE-USE. Using ante-use as a design factor was fairly straight-forward in some senses. The order of doing things and what needed to be prepared, and what could not wait being done even if it would look like that. All training tasks that were not "atomic" got a new vignette written for them.

TOOL INTEGRATION. The design for tool integration was pretty straight-forward. For a task where several tools were to be used, the link was made clear, and the choice of tool/s and their use in time and how the different tools work together was clarified

CUSTOMER-BANK RELATIONSHIP. This was carried through as a constant focus on the customer's bank business, and reminders to check how good a customer the customer is. The course was divided into sets of training tasks structured for different roles at the bank, such as a teller, an advisor, or a manager.

Surprise & confusion

Designing the course to deal with surprise and confusion in use of the teller system was a much harder endeavour. We decided that the goal of

the course would be to decrease the occurrence of confusion, and provide means of solving those occurring, as well as providing means of handling surprises.

Every work of art can be evaluated, in part, as ratio between that which is intended by the artist and not expressed in the work, and that which is unintentionally expressed by the work

Marcel Duchamp from The Interactive Art Gambit ("Do not run! We are your friends!") by Ken Feingold

III.09

Teller system use

This chapter reports on the collection of material on the use of the teller system.

Setting

This is a continuation of the project presented in CHAPTER 08. The learning environment was distributed to a few selected users.

Purpose, character and role

The purpose of the study was primarily to collect data for the assessment aspect in CHAPTER 10, but also an effort to understand what was going on at the user's sites before and after training.

The main purpose of the project was to give the practitioners at FSB the possibility to work with a material collected from their branches in order to have them analyse the use quality content of the material. They also had another purpose: to get an idea whether the course material was good.

Methodological issues

The study was performed in much the same way as in III.07. Users were selected more carefully this time, partly due to the fact that there were fewer users that had not already taken the course in its earlier version, and partly because users with no earlier experience could not be included in order to marginalize effects of the paradox (see I.02) as well as related effects seen in III.07.

We also chose the participating branches carefully, trying to create a mix of smaller and larger branches, as well as branches with a primary background in both of the fusioned banks.

In order to screen participants computer self-efficacy the same questionnaire was used as in III.07 before the use-study.

Conducting

Data collection

To be able to study changes in the use qualities a pre/post study was performed. The pre-study was performed the week before the informants took the course, and the post study was performed approximately six months after that. Five users participated in the study.

The main qualitative part was collected in a use study, through observations, in the pre-study as well as the post study.

The branches approached were carefully selected, so that they had employees which had not taken the earlier teller system course, and so that a mix between different branches was achieved; both smaller and larger branches, as well as with different origins before the fusion.

Five (2 male, 3 female) users participated in the pre-study, only four (2 male, 2 female) of them could participate in the post-study. They all had earlier experience of using the teller system, and came from four different branches of the bank.

Use study

The researcher took part of the user's work, taking notes, asking questions, trying to uncover use qualities. We followed them for an hour up to half a day per user on two occasions (except for one of the users) and took the role of an apprentice, trying to learn more about their work and asking probing questions about the episodes that took place, simply performing situated interviews. The clerks worked both as advisors with booked customers and as tellers at the counters with "rushed customers."

We wanted to cover practical, social, and aesthetic functions, and ethical and constructional issues, and tried to answer the question of what was important in the use of the teller system; what the use of the teller system should be characterized by.

The transcribed field notes were then analysed by a project group at FSB (see III.10). Our own analysis of the fieldnotes followed a similar procedure, identifying relevant use qualities in the field notes and structuring them for usefulness. However, our analysis was also informed by the interpretations made in the workshops with the project group. We read and re-read the field notes creating categories and tried to say what the use of the system should be characterized by.

Questionnaire

A questionnaire was used in the pre-study, primarily to screen the informants' self-efficacy, but also as a possible probe into specific use qualities. See APPENDIX I.

Analysis and interpretation

What precedes use

Before the actual use of an artefact, events and activities take place that set the stage for the actual use. These events and activities are the ante-use of the artefact. An example from the bank:

A opens all windows and systems that might be needed during a meeting with a customer. He believes that it is a matter of loans and therefore prepares loan documents and opens windows showing the interest situation. If it would be a unit trust issue he would instead need the B-menu system. This will ensure a more smooth use of the systems during the meeting, and reduce the risk of getting surprised when meeting the customer. [18]

The preparations can be more or less well made; good preparations will lead to a better use quality in the actual situation of use.

When it comes to collaborative aspects a few things might be noticed.

B gets a customer who wants to make some investments and has heard of something called SPAX (a mixed fund, holding shares as well as options). B turns the screen towards the customer, who wishes to keep some in a traditional savings account. "It is wise to keep 1 to 2 months salary as a buffer." B explains the different kinds of SPAX the customer can choose between, one Media-related (TIME), and one IT-related. "Do you want everything in a SPAX, or parts in a traditional fund and parts in SPAX?" The customer says that he wants only two thirds in a SPAX. "And the rest in interests to stabilise your portfolio? Then the SPAX Worldwide?" The customer asks what he said, SPAX Worldwide? "Yes, two thirds in World-wide". The customer, a bit irritated says, OK take SPAX Worldwide. [19]

Even though the clerk turns the screen towards the customer he is keen on keeping the control and the initiative. To do that he continuously introduces new ideas on how to invest; the buffer, two kinds of SPAXes, SPAX and traditional unit trust, savings account and SPAX, and then SPAX world-wide. In this case the argument was that he would not let the customer put all his savings in a SPAX, and that the customer needed a better-balanced portfolio. The only decision the customer makes is that two thirds should be invested in a SPAX. Through the dia-

logue the advisor is selling as well as preparing for using the appropriate tools.

The excerpt below shows how C prepares herself and the customer for a future meeting:

> *"I would need some advice," the customer says. "I have some forest I am about to sell. Is advice free?" C asks whether the customer has decided to sell. "It is much simpler if you book an advisor in advance." C continues, "Is it a lot?" The customer says that she has a valuation under way. C goes on, "Is it investment advice you want?"* [20]

C continues to pinpoint what the customer wants, without giving any direct advice, only preparing herself as well as the customer for what they will be talking about later during the booked advice. She is showing the customer what to expect and what to be prepared for, while at the same time finding out to what degree the customer is prepared for an investment discussion. This particular customer has currently only a savings account, but says that she owned a SPAX several years ago.

There is also more direct evidence of customer ante-use, the example below shows ante-use based on a misconception:

> *The customer wants to sell a unit trust because she needs a tax deduction. A asks her what she means by "needs". "Don't you want to make money?" "Well, I want to equal a sales that generated profit" "OK. Listen. If you gain 1000 from one deal, and loses 1000 from another, you end up gaining zero, and of course get zero tax"* [21]

The customer then changes her mind. The customer had done some preparations, and had the expectation that selling a unit trust would be the right thing to do to achieve her goals.

Also ante-use has a strong relationship, of course, with earlier experience of using the same tool.

She knew that it would work the second time. And there are other things you need to do twice. [22]

And from doing the same tasks.

She is doing the same things over and over again. Planning the business every year, prognosis every year, etc. [23]

Ante-use is, as is obvious from the examples above, more than just preparations. It is also a matter of expectations. When it comes to the implementation of computer systems at the work place one must recognize that the successful ones usually are informally advocated. People talk with their co-workers about the new systems that they encounter. Creating good expectations is important for success. Too enthusiastic users may, however, be disappointed.

If the clerk expects something out of using a tool for his or her work and does not get that, he or she will either be happily surprised or angrily disappointed (see also Holmlid 1997, 1998).

Surprise & confusion

The factors that add up to creating situations of surprise or confusion come from the system itself as well as from the definition of routines. The advisor in this example was doing the last few things for an approved loan to be registered. Most of the work is done in a special application, but a form needs to be printed out for the archive. She wanted to add a comment on the reasons for approving the loan, reasons which she had used during the loan approval meeting.

From the tool-panel of the loan application she selects "Print out". Word opens up without the buttonbar. She closes Word, selects "Print out" once again. Word opens with the buttonbar. And now there is a print out. "Why wasn't my comment included? Maybe it is becuase the deal is closed?" [24]

She first closed the deal, and then wanted to include the comment. As such it could be seen to be related to the system, but the system in this

case is merely a reflection of a partially computer-based routine. When the deal is closed, you are not allowed to enter or edit a comment.

Integration of systems is also an aspect that the informants put forward as a possible source for confusion.

> *"It should flow between the systems. You often have to get information from many different places, and suddenly you think: 'Where the hell do I find that information?' That must not happen in the meeting with the customer. [...] It's about trust!"* [25]

One informant noted himself the importance of not being surprised at customer meetings. B-son had been on vacation and had a customer booked that he was to advise. Someone else at the office had booked the meeting for him, and since that colleague did not know B-son's complete schedule there was no time to prepare before the meeting. All he had was a name and a civic registration number. There was, however, time to print some papers to get a quick glance at the customer's financial situation. From that analysis he arrived at the conclusion that it had to be a matter of re-binding some loans. He also checked the customer's commitment view and could see the customer's behaviour concerning savings, withdrawals and loans. At the same time he also noticed the "TB4", the profitability of that particular customer. Later on B-son stressed the importance of "not being surprised" in the meeting with the customer.

The ratio of what unexpected things the audience does when they become participants, and which expected things they do not do at all

from The Interactive Art Gambit ("Do not run! We are your friends!") by Ken Feingold

III.10

Assessing teller system use, the second round

This chapter describes the modelling of the material from the teller system use study, performed by a diverse group of practitioners at the bank.

Setting

This is a direct continuation of the project in III.09. After having developed the course material, having had some users do the course, having been out collecting empirical material time had come to assess the use of the teller system in the light of the design efforts put into the course material.

Purpose, character and role

The purpose of this aspect was to assess the ideas of use quality from earlier aspects as well as to further develop the concept and model used.

Methodological issues

We chose to reuse the workshop format from earlier. These were by now familiar to the project group, did not take too much time away from their other tasks, and

were flexible enough to harbour data collection, analysis as well as mutual learning.

For this aspect we also wanted to involve systems developers at the bank. The workshop group finally consisted of three course developers, three system developers and two usability experts/researchers.

Conducting

Data collection

To get a detailed account of what use qualities were identified and what they meant to practitioners at the bank, three workshops were undertaken. They served primarily as interpretative sessions, but in some meta aspects they were analysed as empirical material in themselves. The project group from FSB consisted of six persons, three systems developers and three course developers.

The transcribed field notes were analysed at three interpretative workshops at the head office. One of the researchers functioned as facilitator while the other took notes and handled the video camera.

Workshop 1

The workshop used as its basis the use-study protocols from the pre-study performed in III.09. The participants were asked to read through them before the workshop. At the workshop a brainstorming activity was used. The participants were asked to once again read two of the use-protocols (we chose who read which), and to write down all aspects that would match the ending of the sentence "The use of the teller system [SYNK kassa] should be characterized by …".[1] Each use-protocol was read by three workshop participants. After this the video camera was started, and we started to put up notes on the whiteboard. After that was finished, I moderated the structuring of the notes.

1. One might think of this question as a question about the character of the system, but also of its characteristics (Janlert & Stolterman 1997), since there is not a distinct difference between these in a non-developed language game.

Workshop 2

The workshop used as its basis the categories and groupings from workshop 1. The participants were asked to familiarize themselves with the material before the workshop. They were asked to prepare more general use-qualities, which mattered to them. At the workshop the goal was to categorize and structure the prepared use qualities.

Workshop 3

The workshop used as its basis the use-study protocols from the post-study performed in 111.09. The participants were asked to read through them before the workshop. They were also asked to write down all comments and questions they had during reading, and to single out use qualities, and to rank order them in terms of their importance. At the workshop the goal was to have a round-table discussion based on their comments, questions and use-qualities.

Descriptives

WORKSHOP 1. 184 primary suggestions were generated and 12 groups were constructed from these. During the grouping session 48 secondary or derived suggestions were made (see TABLE 7).

WORKSHOP 2. The project group generated 17 generalized use qualities. The generalized use qualities were put together into a complex structure (see FIGURE 15).

Table 7: **Number of primary suggestions by competence, and derived suggestions**

	System developers	Training developers	Total	Derived
Functionality	28	13	41	3
Way of working	21	11	32	17
Training	10	12	22	3
Customer care	8	8	16	5
Organisation	4	10	14	4
Technology	5	9	14	1
Attitude to tool	2	0	2	3
Market	2	0	2	1
Working environment	0	1	1	0
Bank concepts	0	0	0	1
Laws, policies				1
Leadership				9
Total	80	64	144	48

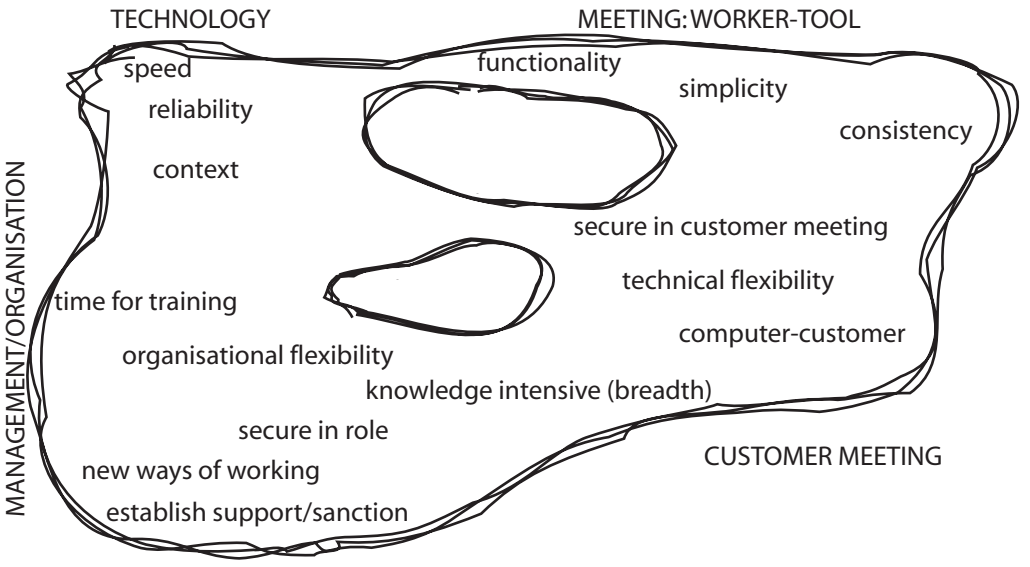


Figure 15. **The structure of the notes and the names of the groups. The "islands" denote that there were no direct links between groups, "white spaces".**

WORKSHOP 3. 15 use qualities were identified by the project group.

Table 8: **Specific use qualities and their rationale**

Use quality	Explanation
Not wrong/right	The systems are not good enough. The training is not good enough. Does not feel comfort using the systems, or in themselves. Does not dare using the new because they do not trust it. Does not dare doing things in the sales support system, uses old systems instead.
Status/standing	Teller work one should not do. It is below me in the hierarchy. It is not status enough to use the teller system. Leaving jobs to the teller. A role delimitation.
Public	comfort in the role. Knowing what the user is allowed to view/see.
Subject of conversation	refers to the computer. Long waiting calls for small talk. The trouble is in the computer.
Pre and post work	That's the way it is because some things do not work, or for security reasons. Or reviewing.
Waiting	It takes time to get certain documents and decisions, because they rely on manual procedures or coordination that takes time.
Notes	mediation through post-its
Rules	some are old or not relevant. You need to assess the validity of the recommendation of the rules, and the consequences of using that recommendation.
Repetitive work	Enter customer data at several points during one customer meeting.
Enter data	There is a lot to enter. But that's the way it works.
Authorization	Roles. Connected to social use. Limits on credit approvals.
Recommendation	Some technology is recommended, some is not. Attitude and resistance towards technology. Twinsafe is problematic in a teller line, but eliminates a lot of post work, which is a benefit a customer rarely sees, and a user might not experience.
Role integration	Customers sometimes go to the wrong kind of person in the bank. Tellers should guide customers to an advisor when they want to sell bonds.
Speed	It needs to be quick at the teller's. The goal of the bank is not speed, but to sell bank services. The teller becomes more stressed by the customers waiting in line.
Private/public/secret	People have shared economies but all information is not shared without specific permits. Advisors are used to not showing anything, and with systems adapted for presentation they become insecure of what they are allowed/may show to a specific customer.

Analysis and interpretation

The power of individual notes vs groupings

Looking at the individual notes the breadth seems good. More problematic is what happens when they are grouped together. To give one example of that, the note "The customers preparation" was grouped under way of working, though it could have been a group by itself together with other customer related notes such as "Customer pressure", "The customer is as updated as the advisor", "Parallel customers". In the grouping activity pre-defined concepts of the individual competencies prevail. It is problematic in the sense that it diminishes the inventiveness on the concept level, even though the inventiveness of interpretation had been high at the notes generating level. The remedy for this might need to be found before invention of new concepts; charting out what is today, as well as dealing with stating and giving up positions within the group, i.e. the formation of the group needs to be performed thoroughly before the brainstorming sessions.

It might be that the brainstorming idea was wrong; even a little group conflict is too much and leads to defensive rhetoric, group think and safe positions.

It might also be that the groupings that were to be done were one level too high. First the participants made specifics, then these were grouped and then the participants were supposed to make up labels for the qualities. It is fairly easy to find atomic expressions for use qualities, and fairly easy to group them (in process of conceptual order). But to give them labels as qualities is in fact a third level grouping activity. In this case the participants had different familiarity with use quality as a concept, they all knew banking (from branch offices, as well as course and systems development perspectives). In order to be able to label the groups, they needed to conceptually mix their banking concept with their use quality concept and invent labels that fit *as well as* combine these two (in order to

be understandable). This is very hard given the relatively short experience of use quality the group and its individuals had.

Different perspectives

It turns out that the participants have different views on use quality. Looking at the top three use qualities for the two competence groups, taken from workshop 1, they are roughly the same; Functionality, Way of working and Training for the system developers, Functionality, Training and Way of working for the learning developers. But looking at the relative frequency of the notes within those use qualities provide a slightly different picture. System developers generated more than a third of their notes with reference to Functionality, while a third of the learning developers notes includes both Functionality and Training. The next one third notes from the system developers were concerned with Training and Way of working while the next one third from the training developers were concerned with Way of working and Organisation. The next two groups of notes from the system developers, Technology and Organisation, account for 6% and 5% of their notes, while for the training developers' Technology and Customer Care account for 14% and 13%. Based on this it is quite safe to say that the system developers in this group had a more narrow perspective of what counts for achieving use quality than had the training developers.

During workshop 2 it was also obvious that they held different perspectives; system developers emphasized such things as speed, reliability, self instructive, *et cetera*. Training developers emphasized knowledge intensity in different tasks with different tools and leadership roles. Both groups identified simplicity or ease of use as important.

This points out the importance of setting up development groups consisting of many different competencies, not only because course developers, technical writers etc should be involved early in order to produce their stuff, but also to because they provide different views of what is supposed to be done, how it might be achieved, what the users want, and how users should be interpreted.

Relevance of our selected use qualities

In our design of the course material we selected a few use qualities which we wanted to promote. They were ante-use, tool integration, and relationship customer-bank.

In the interpretation of the material done by the project group, they make no explicit references to two of these factors, ante-use and tool integration, but they implicitly or indirectly use the concepts for describing the material. One such example is the note "Customers preparations".

ANTE-USE. Apart from the simple example above during workshop 2 and 3 the participants emphasized the role of management for the successful introduction of software and new technology. One such is seen in TABLE 8 above, Recommendation, where management plays a significant role to build appropriate expectations and avoid falsely acquired negative attitudes to spread. In workshop 2 several notes were made where management play a significant role when setting up routines, ways of working, allowing time for training in order to accommodate using the new technology.

TOOL INTEGRATION. In FIGURE 15 consistency refers to issues of smooth tool integration, in two ways. One is about the design of systems, the other is about the understanding on the users part how the different systems fit together. That is, tool integration is not only a systems design issue, but also an issue of system usage. In TABLE 8 it is referred to "Repetitive work" and "Enter data". Both deals partly with issues of tool integration, partly with within-tools problems.

RELATIONSHIP BANK-CUSTOMER. This use quality is the one that they clearly identify as being important. In FIGURE 15 they talk about the customer meeting, "Support in the meeting with the customer", and how the teller system interacts with the customer, "reliability" or from

TABLE 8 "Private/public/secret". Although not specifically defined as a relationship between the bank and the customer, but as a kind of mediated relationship it is pointed out as highly important; "better and more rational business for the bank".

As abstract categories they are not reproduced by the practitioners, but, which is more important, the practitioners define aspects of, e.g. anteuse, which are related to their business. The argument against the general definitions of usability, that one should not try to define usability in terms of Efficiency, Effectiveness & Satisfaction, but instead ask users what it means for them to be Efficient, Effective or Satisfied, when using a specific product, holds for use quality also. Researchers and developers alike need to be sensitive to the specific interpretations of concepts made at sites and not impose a too abstract terminology.

Complexity

The totality of the analysis seem to be fairly complex. It would be easy to argue and say that it is far too complex to be used, or too complex to be a result of good research. As far as its use is concerned, it is the *de facto* complexity that is made explicit. Normally the complexity is abstract or implicit, and the individual practitioners are left with their own efforts of tackling the details and explicitness of the complexity for their specific tasks and goals. By making the complexity explicit it also becomes shared, both as a problem, a possibility, a source for conflicts, and for development efforts. As such it is not an over simplification of the real world situation and a reasonable and appropriate model. As such, it gives the practitioners a language to use, and a structure to understand what is going on.

Developing sensibility for use qualities

We could see that the sensibility for developing use qualities increased in three ways.

First of all the scope of the individuals use quality concept increased with time. What struck us as most interesting was that it happened in such an explicit manner, without any ambitions from our side to create a learning environment. The only learning environment provided was the mutual learning made possible between competencies through the workshops. And it happened quite fast. From workshop 1 to workshop 3 it was only 6 weeks.

Second, the inter-competence critique decreased throughout the workshops, which we interpret as being a result of developing a sense for the other competencies and the way they view use qualities. During workshop 1 the system developers developed the sense that the developed systems are good, it is what the users do with them that is bad. They turned this position into a defensive strategy which put a lot of blame on all problems observed in the use protocol on other's than their own sort; "It is a training thing that users do not utilize short-cuts."

Third, there were initially some critique against the content of the use study protocols. The discussion concerned why the use study protocols contained information about other systems than the teller system, and why it did not contain any material on the teller system training. It reappeared during later workshops; "Have I got this wrong, shouldn't this be about the training?", "What has all this to do with the training? The training is all about button pressing". This bears signs of a weak understanding of why certain data was collected. This might be due to either a weak explanation on the researchers part, or the relatively short experience from working with use qualities form the proponents of that specific view.

In some ways the different competencies in a decreasing manner were trying to reproduce the positions of their own competencies in front and in light of the others, as well as defending their territories.

The advanced model of use quality

As a finale a model of use quality generated as a conclusion of the second round of modelling will be presented. It is simplified in relationship to

the other models presented here, and tries to capture and synthesize the different models as well as intends to describe the different use qualities at roughly the same level. They express what the use of the interactive artefact should be characterized by;

- *Correctness* the results must be correct, especially during customer meetings. Lack of correctness might lead to insecurity, losing face in front of the customer as well as decreasing trust from the customer.
- *Speed* there is always a certain amount of customer pressure. To decrease waiting time and friction in advising situations the system needs to be quick
- *Availability* systems need to be functioning and on line
- *Ante-use* establish support, recommend, expectations, preparations
- *Simplicity* tools should be integrated, their connections should be clear and understood, they should be flexible and possible to be used in parallel
- *Secrecy* customers private sphere
- *Status* use identifies a persons role and group affiliation, and thus their status, customs of usage
- *Trainability* organisation, management, training material

As such surprise/confusion is not mentioned primarily because it was not directly identified in the assessments, but one finds its traces in simplicity, correctness as well as ante-use.

SECTION IV – MODERATO GRAZIOCO

Men samma barn som ritar klockan rund ritar också huset fyrkantigt, som en fasad, och detta utan uppenbart skäl; det är nämligen sällsynt annat än på landsbygden att han får se en isolerad byggnad, och från gatan ter sig även fasaderna som mycket sneda trapetser.

from Alfred Jarry, definition
in Patafysisk antologi by C. Hylinger

IV.II Results and discussion

This dissertation started out with the statement "Interactive artefacts are valued by users and their businesses' for their qualities in use, while the development of systems rarely is managed or valued by the finished products qualities in use." (p 9). That's the primary reason behind this dissertation mainly dealing with creating an understanding of use quality, as a theoretical concept, and grounded in empirical work.

The aim of this research, as well as the thesis, is to theoretically ground and describe the understanding of use qualities gained cooperating with learning developers, as well as further theories of use quality. The knowledge interests posed in 1.02 were formulated in a wide style. The findings, results and contributions span the space of possible answers to these knowledge interests.

Eight points will be made; 1) the conception and usefulness of »surprise» &»confusion», and 2) the conception and usefulness of »ante-use», 3) the role of the »interactive artefact regarded as a learning environment» and for »teacher's use», 4) a brief note on the »interactive material», 5) issues of »heterogeneity» and 6) consequences of »pluralism», 7) implications for »assessment of use quality» in design processes, and finally 8) the conceptualization of »use quality».

Discussion and implications

A few points are made here that has implications for the design of interactive artefacts, and theories of use quality. They might be considered to be use qualities or adding to the growing body of knowledge of the interactive material.

Surprise & confusion

It comes as no surprise that users get confused by applications they are trying to use. The interesting part is that traditionally it would have been considered something wholly unwanted (see e.g. Nielsen 1993). Norman's two gulfs are an expression of this (Norman 1986). But, for someone who is trying to help people learn about using an application, confusion, as well as surprise, are points of departure for creating learning opportunities, unwanted or not.

KNOWLEDGE INTERESTS. In surprise and confusion lies two different, sincere knowledge interests. For the surprised user, the interest is what s/he actually did. For the confused user, the interest is what s/he should be doing instead of what s/he is doing. The surprised user has a historical interest for future use, whereas the confused user has a futurist interest for immediate use. Both users are in a situation where learning is possible, needed and to some extent wanted. Schön (1983) discusses what he calls »on-the-spot experiments». In on-the-spot experiments the consequences of an action in relation to its intention and the desirability of the result achieved play important roles. A surprise, in the sense described here, would be similar to an action leading to non-intended results but desirable consequences. Schön suggests that this affirmation is enough for continuing work, unless one wants to learn for future similar situations. This is similar to the historical knowledge interest suggested here, where the user wants to learn, but finds no support for this in the interactive artefact. A confusion would be similar to an action leading to non-intended results and undesirable consequences, often several

such in a row. Following Schön, it is suggested that when a confusion appears, new trials will be made until a desirable consequence is achieved, be it from an intended or non-intended result. The action and its results and consequences are affirmed. Extending Schön's conception of reflection-in-action, I would also suggest the case where new trials are made until the user for some reason no longer devices new on-the-spot experiments. In both cases, the on-the-spot experiments will be part of a learning process which alters the user's intentions and expectations, in the first case successfully, but in the second case probably with frustration as a side effect.

Carroll and Aaronson (1988) describe a study of two different kinds of help, »how-it-works» help, and »how-to-do-it» help. Their how-to-do-it help would possibly help the confused user, and maybe providing limited learning of procedures, but these messages cannot catch the surprised user. The how-it-works help primarily focuses on the user who prepares himself; at least these messages do not provide any explanation of what the user actually did.

Thomas, in his study of long term exploration (Thomas 1996), identifies a retrospective knowledge interest, which he calls serendipity. As a concept, serendipity is fairly broad. Surprise as it is described here could be interpreted as a kind of serendipity. As such, it is interesting in itself, because it is a sudden accomplishment without prior learning, and with only a partial understanding of how the result was achieved. The surprised user, as opposed to other cases of serendipity, is experiencing first-time serendipity, and might experience another kind of serendipity in the same situation, if no learning takes place. On the other hand, this other kind of serendipity could be a signal that the user in fact learned something while being surprised. In their modelling of users, Kay & Thomas (1995) consciously exclude especially the accidental invocations of a function, which might act as surprises.

In a study of exploratory learning strategies (Rieman 1996) the category »stumbled onto by accident» was used only in very few occasions. The system he studied did not provide any specific support to learn from

the surprises, simply because systems in general do not account for those kinds of situations. The most used strategy was trial and error, which in some cases would be the same as the confused user trying to find out what to do.

Thomas (1996) also points out, as a variation on the Zone of Proximal Development, ZPD (Vygotsky 1981, Engeström 1987), the Zone of Exploration Model, ZEM (Thomas 1996). The surprised and the confused user are both in state of the ZEM, as well as in a ZPD. Possibly, if there is a breakdown, which allows the user to reflect on her actions, the surprised user enters her ZPD, in which the piece of software has accidentally acted as the more capable peer. The confused user, on the other hand, is in need of the more capable peer in order to be able to enter her ZPD.

It is evident that surprise as well as confusion can be a basis for micro level learning environments that deserve to be further explored.

BREAKDOWN ELASTICITY. Neither the surprised nor the confused user can be said to have had a breakdown, in relationship to the tool they are using. There is often an articulated reflection over their use, but it does not stop them from continuing with their work. In Heideggerian terms, the tool is still ready-to-hand, not present-at-hand. There is reflection *in*, and not detached from, use.

Also, in FRAMING A PARADOX in 1.02 (or see Holmlid 1995a) surprise and confusion were extremely obvious, but the further forward in the empirical work presented here the more hidden it became, but there were both surprises and confusions; thus there seems to be a kind of elasticity in their obviousness to an outside observer.

Taken together, this seems to point towards an elasticity in traditional conceptions of breakdowns. Surprise and confusion never cross the thin, but bendable, border between continuous use and breakdown, a zone which allows for reflection in use, or reflection-in-action in Schön's words (Schön 1983).

Carroll *et al* (1987/88) point towards four principles which a system should meet.

- help users set the appropriate goals
- offer helpful hints on how these goals might be achieved
- provide users with checkpoints and means of confirming that they are heading in an appropriate direction
- assist users in recovering from errors

These principles are scaffolds for designers to avoid designing systems where there are constructional limitations that cause surprise or confusion. Still, they do not capture the more domain specific utilization of systems, unless they are highly tailored and focused systems. You could of course define surprise and confusion as errors, but the users in the study performed here do not. To them it is yet another problem solving activity, which might involve exploration; not only of interface possibilities, but also of the original problem (or even problem formulation).

Norman (1988) talks about costlessness when it comes to exploration. The idea is not very worthwhile, because all actions have costs (and usability engineering stresses that by focusing on the ROI of usability (see e.g. Bias & Mayhew 1994, Nielsen 1989, Nielsen 1990), especially so have irreversible actions. Surprise and confusion carry costs with them, but also potentials for development.

Norman also points out that; all actions possible should be visible, they should be possible to be performed, and the effect of every action should be visible and readily interpretable. Surprise and confusion could be taken as a critique against the design of a system not fulfilling these two criteria. However, surprise and confusion is more a critique against the idea of putting up those criteria. If only the accurate/appropriate actions were visible at the appropriate times, less confusion would be induced. Learning by doing is not always to be able to explore, sometimes it needs to be guided.

Polson and Lewis (1990) focus on novices. Unfamiliar settings occur as a relationship between domain, application, user and task. Oosten-

dorp & Walbeehm (1995) suggest that feedback might be necessary only for novice users at an early learning stage. This assumes that the system can decide whether the user acts as if she were a novice user in relationship to the task as well as in relationship to her usage.

USER CONTROL. Traditionally the concept of »user control» has been emphasized in user oriented systems development. That is, the user should feel in control of the interactive artefact, and not the contrary. Cooper (1996) points out several fundamental design considerations that are needed if one wants to achieve user control, through a critical assessment of design exemplars. With a slightly different perspective, taken from drama theory, we do not want to design for suspension of disbelief, but for promotion of reality. That is, on every occasion of use, the user should have a fair understanding of how much in control s/he is. This would account for, e.g., early detection of problematic situations. However, it seem to be hard to provide promotion of reality without designing the interactive artefact with a strong connection to its context, its use and the content and goal of work for which it is applied. For artefacts of today, one strives for a high degree of user control in all occasions. However, this is a false goal. It provides the user with a discongruent understanding of the control s/he has over the tool and the control s/he has over the work s/he is doing. This is especially true when actions taken with the tool in smaller or bigger steps lead towards a problematic situation. In fact, interpreting these design solutions as suspension of disbelief is not far-fetched. The suspension is, maybe unintentionally, an effect of decontextualizing the interactive artefact. Thus, there seems to be a trade-off between user control on one side and surprise and confusion on the other.

Surprise and confusion of course must be interpreted and used differently for different interactive artefacts, or genres of artefacts. It was obvious for the educational designers that they could be useful, but for the systems developers they seemed to be unwanted aspects of use.

Notification applications, especially safety critical or operations and maintenance systems with alarms, are full of surprises. It is not far-fetched to say that they should be characterized by surprise. And all but characterized by confusion. In these kinds of applications these two use qualities are crucial.

In interactive art, or any kind of art if you will, surprise and confusion may be used as means as well as goals. Dan Wolgers'[1] boxes are a nice example of that (see e.g. Wolgers 1996, or better still an exhibition of Wolgers work). One of them (Wolgers 1996, p 25), an old wooden box with a hinged lid, and a coin slot in the foremost right corner, on the top of the box lies a coin. You pick up the coin and insert it into the slot, which through some mechanism throws it back through the slot. It jumps out of the box. Surprise and confusion might even be ignored, consciously as well as unconsciously; it might be that things happening in an interactive piece of art surprises the viewer, although it were not intended to do that. An artist has the possibility to work with concepts on several different levels, as layers. The engaged layer is the one most alike using a piece of software. Unless surprise and confusion guides or is a part of the engaged experience of the artwork, surprise and confusion is avoided at this layer. Other layers, such as a reflective layer might incorporate surprise and confusion although the engaged does not.

> *the ratio of what unexpected things the audience does when they become participants, and which expected things they do not do at all*
>
> Feingold 1997, "Sexual jokes" slide, para 45

If one believes that surprise and confusion can be handled by a usability concept, extended or not, one has to try to make them fit into a construction process. This means that surprise and confusion need to be operationalized, and eventually measured, through one of the traditional methods of evaluation taken from practical HCI.

Formulating usability requirements on confusion would no longer be as easy as saying that there should be no more than a specific amount of

1. Dan Wolgers is one of Swedens most important contemporary artists, former professor of fine arts at Royal University College of Fine Arts, Member of the Royal Swedish Academy of Fine Arts, now full time artist

confusions in a set period of time for a user with profile X under defined contextual conditions. There need also be requirements stating that known or found confusions, might they be few, should be dealt with in training or documentation. Thus, the usability assessment process need to be equipped to discover confusions of an application.

From a use quality perspective surprise and confusion fits nicely as two of several use qualities, and benefits from having an aesthetic, social, constructional as well as functional and other perspectives. In a design perspective we would be able to design applications that uses or foresees confusion points, and helps the user out to learn when it suits the user. This would be possible through social or constructional means; by teachers or by instrumented software.

Designing for confusion or surprise would not require any measures of surprise or confusion. Throughout the design process designers, users, and programmers, *et cetera*, would ask themselves; What is it, or what does it mean, that this interactive artefact should be confusing or surprising? How do we design it to be just that? Assessments would be done, but on the specifics of what makes the artefact surprising or confusing.

Regardless of our view on usability/use quality what becomes evident is that surprise and confusion, regarded as design considerations, do not appear unless confronted with a real use of the application. Therefore, we need to utilize contextually rich methods to be able to handle issues regarding surprise and confusion. HCI needs to incorporate surprise and confusion as a matter of fact issue to be dealt with, not only as something to design and prototype away, but as a direct means for designing better interactive artefacts through other means than the artefact in itself.

As a matter of fact, surprise and confusion are pointers towards an expansion of a set of criteria on usable systems that deals with toolness, "self-efficacy", *et cetera*. It is a domain, or rather a cut through a set of domains, a cut which is largely unexplored,[2] or at least underutilized and under-researched. One challenge is how to study, or get to know things

2. Some work has been done regarding this (see e.g. Kirakowski & Corbett 1990)

about, those aspects of use that rarely surface, and when they surface withstand classically inherited overutilized human factors interpretations.

Surprise as well as confusion are closely linked to breakdowns in usage. There is a challenge ahead to nuance research on breakdown, in part to regard breakdowns not always as something bad, but, depending on in which use and under what circumstances a specific kind of breakdown occurs, as something useful or usable. A breakdown might make the product easier to learn. In order to do that, breakdowns need to get a character. Surprise and confusion, as they appear in the use of the word processor as well as the teller system under the circumstances described in SECTION III, are two such vivid characters. As such, they provide breakdowns with a knowledge interest and a direction. They provide aspects of breakdown elasticity, the thin, but bendable, border between continuous use and breakdown, a zone that allows for reflection in use, without breaking through the barrier into reflection detached from use.

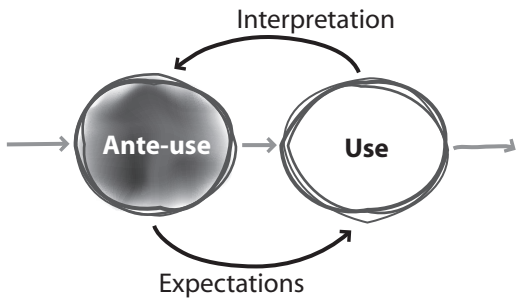
Ante-use

At first glance, ante-use might seem as just being preparations. Of course, preparations is a part of ante-use, but several other aspects are worth mentioning (see FIGURE 16 for a simplified illustration).

Looking at preparations, for some kind of systems it might be better to design them process-oriented rather than open; more like wizardware. This would lead towards systems that are more inflexible. But, some work tasks are very inflexible from the beginning, such as handling loans. There are strict routines to be followed, and checklists are used to support that. Other tasks are externally defined and controlled by regulations and legislation.

For other, less regulated tasks, two alternative genres of systems could be imagined given the role of the interactive artefacts at the bank.

Figure 16. **A simplified view of ante-use**



One, which is like an empty sheet, is completely open. The advisor would use the empty sheet to document the customer meeting. After the meeting, s/he execute whatever was agreed upon during the meeting. This would merely push part of the work now performed during customer meetings, such as looking up information about the customer's account, the interest situation, and so on, to back-office work after customer meetings. The other would be designed in an object-oriented fashion. The advisor would only have to select two accounts, a transaction relation between the objects would be set up, then the advisor would enter the figures for the transaction. Ante-use will have different interpretations within the two genres.

Choosing between genres is a matter of the tension between open and controlling systems and how to minimize advisor-computer interaction, in order to allow the advisor to focus on customers. Given that most users perform a mix of work-tasks, some of which are highly routinized, and some of which are not, a mixture of genres would be expected. In the case of the bank, when back-office work is tolerated by the bank, one could imagine fairly open systems for the customer meetings, and more controlled process-oriented systems for preparations and back-office work after the meeting. During ante-use, the customer meeting is prepared, some work that can be anticipated is scheduled, and after the meeting data needed is entered and what has been agreed upon is executed.

Marketing of an interactive artefact can for some products be a strong influential factor of expected usability (Keinonen 1997), and internal marketing of an interactive artefact that is to be installed for users influences their conception of what it is like to use the interactive artefact.

A person, e.g. a manager, has the power to create certain expectations on an IT-artefact for the benefit of herself, productivity, or the added value the company creates. The expectation given to the users can be one of modern equipment giving them more possibilities and freedom (instead of less time spent on tasks, tighter coordination, *et cetera*), a better working environment (rather than a higher degree of debitable time,

et cetera). As such, expectations become a complex quality of use, presupposing that the ethical and aesthetical quality perspectives are irreducibly intertwined. But the room for a user's expectations on herself, such as self-efficacy, is hard to find in a simple artefact model excluding the user. Management, on all levels, thus is part of the ante-use of an artefact.

Attitudes, experience and knowing before use how to use and/or what to expect from use are also parts of ante-use. Described in this fashion ante-use becomes an extremely important aspect of use and use quality.

Ante-use and use may be considered as two ways of describing a continuum. Any specific period of time, or any specific series or set of actions, might be considered as a use as well as an ante-use for some other use. This loosely relates to the concept of not separating thinking from doing, as discussed by Schön (1983). The twin character of use is yet poorly developed.

It is hard, nearly impossible to view ante-use in the perspective of usability. A seasoned usability engineer might suggest that one should measure attitudes and experience as a way of defining the limits of ante-use. The weakness of such a solution is that it decontextualizes usability and ante-use, as well as separates ante-use from usability, which not was the intention.

Consider ante-use as a use quality. Expectations on use might be based on a non-use. With a model of use quality, the non-use is presupposed. Thus, non-use also becomes a use quality. Expectations based on non-use can be, e.g., the result of a person's will to achieve a certain result of the use, not necessarily the user, which would not be possible without that specific expectation. The use quality is then dependent on the non-use of the user, and the idea of use of the manipulating person.

In addition, the non-use non-manipulated expectation a user builds until the situation or time of use results in a non-use based use quality. A model of use quality needs to open up for the inclusion of expectations.

As a result of that, we need to admit that such a position presupposes expectations and the lack of expectations not connected to usage. It will not be possible for users to enter a situation of use non-expectant. In fact, as expectations in use are partially based on non-use expectations and expectations constructed before use, one might say that every interactive artefact is always already made use of (*swe*. för-brukad).[3] Any interactive artefact's ante-use (*swe*. före-bruk) is also a use quality.

Everyday learning

When designing an interactive artefact, one also designs the everyday learning environment for that artefact, and especially so when it is a tool. To be aware of that and consciously design the pluralism of learning environments, or design for learning environments (with the teacher as a user, or the simulator builder as user), would make the products of today even better. In this effort, use quality is a powerful tool, because it does not focus on the system as an object, nor the user's competence, in isolation from one another. The parallel, making the development of learning environments an integral part of systems development, is an extension of other integrative efforts (see e.g. Carlshamre 1994a, 1994b, Grice 1988). Moreover, integrative efforts are needed in order to be able to provide better learning environments including the interactive artefact. That is, putting learning to use the artefact and the development of learning environments before systems development, thus demanding of systems development to subsume to learning.

Surprise and confusion can also be made to play an important role here; as the initiator of learning processes. Schön (1983) even argues that surprise and confusion are the very flesh and blood of reflection-in-action and thus learning. Surprise and confusion regarded as potentials for learning suggests that we might design micro-level learning environments, which might be used in reflection-in-action. Nevertheless, in many cases there is no time for learning directly. One might therefore envision an interactive artefact that allows the user to record the last few actions and store them for later learning use, provides a mechanism to

3. In Swedish we would say *för-brukad*. The meaning of the Swedish word *förbrukad* is "consumed" as well as "used before" or "already used". Unfortunately, this play with language cannot be made justice in the English translation, . The play with words is made explicit through the defamiliarizing effect of the hyphen *för-brukad*. That is, before we use a piece of software we have already consumed it in some way, as well as it is consumed during our using it.

assess and replay these, provides mechanisms to share such interaction histories, and use these to anticipate help needed in future problematic situations (Holmlid 1998). Interactive artefacts of today are not equipped or designed to allow for these learning uses, the impact of the vision is partly on system architecture.

In a usability perspective, the everyday learning environment view provides an extended set of criteria of usability. The criterion that needs to be added is teachability, i.e. the interactive artefacts' ability to usefully and effectively lend themselves to be used by learning designers for the design of learning environments. Furthermore, learnability as a criterion gets a more complex character, including learning from mistakes, *et cetera*. The weakness of extending usability is that the different kinds of uses and the different users are separated from each other, and in a hierarchical breakdown procedure of usability goals important trade-offs between them are neglected, and they become decontextualized.

Challenges of the interactive material

With a use quality perspective time and tempo as design considerations are obvious, given that it is interaction we are dealing with. We expect an interaction designer to design in accordance with a sense of time. The time-dynamicity of the interactive material is a given. Beyond the fairly simple expressions of this, such as time and tempo, one might suggest more complex qualities such as »phrasing», »pacing», »syncronicity» *et cetera*. A development towards this is presented in FIGURE 17.

Figure 17. **A more detailed model of dynamicity and activity.**

Yet other design considerations of the interactive material are allowed for by a use quality perspective. Two such, which a designer needs to develop sensitivity for, are »consonans» and »dissonans». Today a non-consistent user interface is regarded as being of low usability, whereas the goal is to produce consistent user interfaces. Merely using the words consonans and dissonans gives a designer the possibility to do good design for both, which the traditional X/non-X qualities does not allow for.

Using the consumption styles defined by Paulssons (1959) as a template, one might describe an interaction designers consumption, or use, of design in design processes. The autonomous style would correspond to designers that freely chooses the way to design an interactive artefact to fulfil its differing purposes. As an autonomous designer we may understand, e.g., Kai Krause, and others who have invented new interaction design styles that has not taken on broadly as design exemplars. The anxious style thus would typically be to conform to the most prominent style guide for the application area; such as the Windows style guide. This style of consumption is the one that is proposed implicitly in most literature on user interface design. The eager style is harder to find examples of.

Heterogeneity

It is fairly easy to study and pinpoint one of the most common qualities of environments of use and learning, their diversity. Here only a few aspects of this will be mentioned (see also Holmberg 1996, and Busch 1993 for other overviews).

Software diversity has several dimensions. Of minor importance is the within-application version problem. Most of the time there are several different software families run in parallel with more complicated across-application or across-families problems, sometimes due to version differences. It is also fairly common that there is a proprietary system, especially at large companies, with quite a bit of installed base. There might be different versions of the same operating system running, or a user switches between more than one operating system. Alternatively, differ-

ent users might use different operating systems, or even different computer platforms. It is hard to foresee any reduction of software diversity at workplaces unless there is a drastic change, such as a shake out or technological stagnation, in the information technology field.

Then there is the learning environment diversity. Focusing only on off-the-shelf software there is teacher-led training, self paced computer or non-computer supported instruction, third-party books, written manuals, on-line help, *et cetera*. For the range of different software one person uses at work a few of these might be chosen. There are informal and formal learning environments, task-focused or task-free exploration, *et cetera*. It is hard to foresee any changes in learning-environment diversity due to technological development pressure, the introduction of new learning media as well as learning philosophies.

Task-diversity is manifold. Users are experts at doing their job, but to varying degree experts at using certain pieces of software for different tasks. To be able to do their work smoothly they depend on others being experts at, e.g., operating systems and mail servers. Most work-tasks require the use of several pieces of software. The frequency of the work-tasks varies as does their complexity, with changes over time.

Given that there will be no great revolutions in standardization, users will encounter a diverse environment of interactive artefacts, learning environments, *et cetera*. Designing with such »gaudiness» in mind is something completely different than designing with most available general guidelines. With the value base of a Western or a modernist society, a minimalist design following rigid principles would be proposed, such as those expressed in Scandinavian design,[4] based on the faith that technology has the potential to, and eventually will, solve the perceived problems of heterogeneity. With another value base, the gaudiness would be welcomed and ornamentation would be proposed as a way of embracing this, just imagine a Rajastan bus.

Let's paraphrase Åhlberg (1993, p 105). *"But is it Usable? What we should worry about are the reasons given, if any, for the judgment that some-*

4. Although from a different cultural sphere, traditional Japanese design culture would imply the same solution.

thing is usable, because these arguments will characteristically appeal to values and norms, and thus will reveal the underlying conception of usability."

Pluralism

One side to pluralism is taking perspectives (e.g. Ehn & Löwgren 1997). Another side to pluralism is to shift philosophy of use. Descartes would provide us with the division between subject and object, Wittgenstein with language games, Heidegger with objects-in-use, dasein, Habermas with the ideological actor, Leontjev with mediated actions, and so forth. This would also open up a large white space of underutilized philosophical "paradigms" to be used for explorative as well as normative purposes; post-modernism, post-structuralism, feminism, psycho-analytical theories, neo-Sokratism, *et cetera*. In that way the powerful influence of anglo-american philosophical traditions, e.g. Dewey's, will be complemented with continental philosophical traditions, such as those of Adorno, Baudrillard, Bourdieu, Deleuze, Derrida, Giddens, Kolb, Lyotard, Merleau-Ponty, Ricœur, Virilio just to mention a few. One driver of this is the ongoing cross-fertilization between interaction design on one side and art, narrativity and other design intensive fields on the other.

With pluralism will follow »institutionalization». The quality of a piece of software has long been regarded as a property of the specific product, so has usability. In that sense usability has been viewed as an »essence»; coded into the pieces of software in a more or less difficult manner.

With such a view the question one is asking oneself is "What is good usability?" In parallel to art, another view of what usability is, might be proposed. It has become institutionalized. Lending from Dickie[5] (1971) a usable piece of software is

> 1) *an artifact* 2) *upon which some person or persons acting on behalf of a certain social institution /…/ has conferred the status of candidate for appreciation.*
>
> Dickie 1971, p 101

5. Dickie formulated his concept of institutionalization within the world of art.

The second point of Dickie's is also applicable when trying to define what it means that a piece of software is usable. Such a definition is of course not without problems (see e.g. Dickie 1971, Danto 1964, 1994, Vilks 1987, 1995, Lord 1987 for treatments of institutionalism within art theory). Paraphrasing Vilks we would say that "a *piece of software is usable because the field of* HCI *regards it to be usable*" (Vilks 1995, p 108). And that usability is 1) the sum of efforts to define it, 2) to construct its history and 3) to give it an own identity (Vilks 1995, p 108).

Or to paraphrase Åhlberg: *"I have said that we should not worry too much about the question 'But is it Usable?'. What we should worry about are the reasons given, if any, for the judgment that something is usable, because these arguments will characteristically appeal to values and norms, and thus will reveal underlying conception of usability."* (Åhlberg 1993, p 105)

Strikingly enough one of the central figures for usability as essence, Jakob Nielsen, is also one of the strongest forces of the institutionalization of usability, and one of the most influential institutions the field of HCI has. In fact he refers to this, with the voice of a usability despot, in an interview during the Nielsen Norman Group world tour of 2000:

> *A guru is a super-expert who defines the field /…/ And that's what I view my mission as /…/ In the future, first of all, websites will be designed by my guidelines …*
>
> Wired News, 15 nov 2000

Kirakowski & Corbett state that "*It must be emphasized at this stage, however, that hci as a discipline has most probably not yet formed an institutional set of attitudes …*" (Kirakowski & Corbett 1990, p15). During the decade since they wrote their book I believe institutionalization has become real within our field. In the shadow of essence versus institutionalism it becomes important to consider the history of HCI, as well as of usability. So far the history mainly has been dealing with how interfaces are constructed, and how production of interfaces and the analysis of interfaces come together under shared understandings. We see this in the method-

ology movements, the language sharing movements *et cetera*. What we are lacking is the time bound history, looking backwards through the glasses of the shared understandings defining what interfaces were usable and who were the actors of usability. This is a history that would gain from, and need, being rewritten along the way as the shared understandings change. We are also lacking the history of critique against the shared understandings. Such a history would be able to focus on the development during times of change, such as the influence of Kai Krause's inventive and organic interface designs.

Usability is not equipped to deal with a pluralism of this kind, being a rationalistic engineering concept. However, usability might prosper from being institutionalized, it has reached a point in its maturity as a concept where it is appropriate with strong institutions to support and develop it. On the other hand, use quality has pluralism at its core, and thus embraces institutionalization as a part of concepts developing and maturing.

Use quality, indicators and values

The concept of use qualities not only brings with it a new perspective on interactive artefacts. It also brings with it a new look upon assessment, or evaluation and metrics as it is most often called. There is no dissonance between the qualitatively rich approach of use qualities and a more traditional metrics oriented. It is only the way to view metrics that changes. As a concept there is in fact nothing new about this, but in usability practice and in HCI education it is not presented in quite this fashion.

At the very bottom of it all there is a value basis, be it an organisation's, a culture's or an individual's values, or mixes thereof. With the values as a basis use qualities are formulated. From these more specific factors might be stipulated. Indicators can be coupled to these factors, in order to measure whether a design results in the use qualities sought. Thus, a quality indicator should tell whether a factor, which is supposed to relate to use qualities, is heading in the right direction or not.

This means that a measure of, e.g., efficiency is in itself not the same as usability nor use quality, but, measured as time to task completion, is an indicator whether we are designing and developing the artefact in the neighbourhood of what we intended. It is a quality indicator, not a quality in itself.

It is quite evident that the naïve form of usability has limited itself to formulating these measurable usability goals, what I call quality indicators. Usability has missed out on the last link in the following chain; to be able to state a value we must measure, to be able to measure we must specify goals, to be able to set goals we need to work with values.

Another aspect of the new perspective on assessment is that we do not wish to do a top-down analysis of use quality, but rather start as a bottom-up constructive effort, that can be complemented with a top-down analysis later on (in the construction phase) or other ways of synthesizing a whole from the parts.

Referring freely to Blanchot (1990) it becomes clear that not only the product needs to be prototyped, but also the assessments to be used needs to be prototyped as well. For Blanchot the product is in itself enough, an assessment cannot say anything new about the product or give it a value of its own; therefore the assessments need to be "a part of" the product. In a context which bears the signs of an engineering culture, using and developing models which focus on hierarchical breakdown of concepts fit very well. In other work cultures, the idea of the sum of the parts is not accepted.

A more general approach is to describe values, use qualities, and quality criteria as three interdependent areas. For the different quality criteria, indicators can be identified, and for the indicators measures. Within this view it is possible to work in a breakdown manner, or to value-ground all criteria, to work top-down or bottom-up. But most important it is possible to easily switch between work modes. Thus it is possible to establish a richer picture of the use of the system to be implemented, as well as pro-

ducing several representations of this picture, which one is believed to fit the best for a specific goal, context, use, or stage in the development process.

There is neither a simple one to one correlation between values and the others, between use qualities and the others, nor between quality criteria or indicators and the others. The order in which they are walked through is not pre-established, and when defining a quality indicator for a specific quality criteria, the indicator might be evaluated against all other indicators, quality criterion, use qualities and values expressed. Thus, the complexity of assessing a design is charted out, odd trade-offs might be foreseen and ingenious ways of assessing use quality might be found and established.

An approach such as this would also account for dealing with considerations of differing cultures of participants in a development process, such as those displayed by the project group in CHAPTER 10. They saw different things, looked at the user in different ways *et cetera*. It is more inclusive and opens up the design space for a wider range of concerns, as well as allowing for professional cultures used to perspectives of interpretation (such as actors, designers, musicians, *et cetera*) to participate on more equal grounds.

Specifically concerning assessments, the study performed here reinstantiated the fact that there are differences between novices and learners, but also between low-confident and high-confident users. This is important especially for its effects on doing broad studies of unmatched »low-achievers» and »high-achievers».

THE ROLE OF THE DESIGNER. It is, in our eyes, the job of the interaction designer to stand in the middle of the practical, the social and the aesthetic. He or she has to give form to an object and participate in conveying use qualities, while making it possible for a design team to create a practical, social and aesthetic use with acceptable quality in all three aspects. At the same time, there are constant considerations of construc-

tion and ethics. On one hand, what are the possibilities and constraints of the material and the production, and on the other, what are the constraints and possibilities of personal, professional and societal ethics.

The different uses are not to be seen as complementary but as perspectives of a whole – the use of a system (Holmlid, 1997c); a design decision concerning practical use should be considered not only from a practical perspective but also from, e.g., an aesthetic perspective. It is important to consciously alter between different perspectives when approaching an artefact-in-use to capture the wholeness of use and not only pre-conceived fragments of it.

As products and technologies develop and die, so will businesses, thus the conditions for working with usability, use quality and interaction design will change. One future development is that we will experience customers and procurers build up their usability competence. In the longer perspective there will develop procurement competence of use quality, which in several aspects differs from the usability competence of today's HCI-practitioners working with systems development or as free agents.

Use quality

Again, let's paraphrase Åhlberg

> *"But is it Usable? What we should worry about are the reasons given, if any, for the judgment that something is usable, because these arguments will characteristically appeal to values and norms, and thus will reveal underlying conception of usability."*
>
> Åhlberg 1993, p 105

Going from usability to use is a small step for practitioners but a large step for research. Many practitioners already have a wider scope than the ISO-definitions of usability, and try harder and harder to be involved in as early stages as possible. For the researcher, it is required to embrace

new epistemologies and ontologies. Some researchers already act under these new conditions.

There will be no general model of use quality presented. It is my belief that there cannot be one either. There will be tools, techniques, methods, *et cetera*, which may be used to convey use qualities, and assess them. Several such have been discussed here; ante-use, dynamicity/activity, surprise/confusion, *et cetera*. The models will always be tentative and subject to change without further notice. It is the role of the designer to be sensitive to such changes.

It will always be the present understanding of the use, limited in its scope by the people, tools, culture, time-frames, *et cetera*, that will be used to form that understanding. This is important. To understand and to act upon, to be able to recognize the limits of a model when they are approaching, and ways of improving it, maybe even possibilities for improvement. We need to be self-critical enough and insightful enough to recognize a situation where we can rely on our understanding of the model as well as our understanding and sensitivity to perceive the actual use, and when we need to alter these understandings with the appropriate methods, to reflect-in-action.

Jag sjunger för mycket kyss mig tyst

from Guld in Ragamedon 2048
by Organic Revolution Orchestra

IV.12

Critique

Combining a hermeneutic approach with a critical theory reflection prevents both the hermeneutic circle to become merely a reflection of the researcher or her institutions (Alvesson & Sköldberg 1994), and the critical theory to be speculations devoid of empirical grounds (Bourdieu, Chambordeon & Passeron 1968).

In this chapter one critical claim, of possibly several overlooked, will be assessed, as well as the research process. The former will be done in the form of critique, the latter will be done using *transferability*, and the three methodological horrors, described by Banister, Burman, Parker, Taylor & Tindall (1994); *indexicality*, *inconcludability* and *reflexivity*.

Critique

Does this research, in spite of its intentions, reproduce or enhance the outset of the critical claim it stipulates, and on which it is based? A cluster of questions, loosely drawn from Alvesson & Sköldberg's analysis of the dialectic between Habermas and Lyotard (Alvesson & Sköldberg 1991), are posed to address this critical claim; *There are significant differences between usability and use quality*.

There are significant differences between usability and use quality

IS A TRADITIONAL CONCEPT OF USABILITY/CONSTRUCTION REPRODUCED? First, a crucial point is that usability defines the context as something passive, or given[1], whereas use quality does not give context a differentiated or generalized role or status in relationship to other units of analysis.

Secondly, use quality neither implies nor assumes a subject-object dichotomy. Instead the actions, the »use», is the starting point.

One rationale often used by usability proponents is that spending on usability decreases learning costs. Of course, most of the time these are speculative calculations, rhetorically used for organisational political issues, or in sales meetings. When it comes to use qualities, costs for learning and costs for systems development are seen as a whole, make them interdependent. In that sense, it becomes possible to prioritize between spendings across organizational borders, to prioritize between activities across organizational borders for their contribution to the shared objectives. It also makes it possible to assess not only the benefits of systems development on training, but also of learning periods on systems development.

Thus, it can be said that use quality does not reproduce what usability already has done.

IS A TRADITIONAL CONCEPT OF USABILITY/CONSTRUCTION REINFORCED? Every concept claiming to be more, better or instead of usability will in some ways reinforce the traditional concept of usability. Jakob Nielsen's stronghold partly rest on his position to outrule anything new, or different, to be better treated by his concept of usability, and his heuristics for design of usable software.

So, as a matter of fact, the research performed here reinforces an essentialist position to usability, but also introduces the fact that we are

1. Context is one of those things that needs to specified for the usefulness of usability. In that sense it is taken as given. At the same time context it passivized, whatever is implied in the context is not allowed to influence usability. With a vague context concept that comprises everything else than the user, the task *et cetera*, many aspects that influences the use of an interactive artefact is passivized.

facing an institutionalized concept, as well as an institutionalized field. Use quality takes the institutionalization for granted, and is in this sense stronger and more far reaching regarded as a tool, than usability is. It might just be that this reinforcement of a seemingly weaker usability concept – a focused concept, primarily concerned with product properties, with established tools and techniques, aimed at the construction phases of systems development – give usability a stronger and more appropriate position, as well as makes it possible to mature as a research field. From such a position usability could advance to becoming industrialized; industrial usability. The danger is when proponents of usability or an essentialist view fail to see the wider range within which their own perspective is a limited position to take.

Thus, the reinforcement is a vehicle for both usability and use quality to prosper.

IS THE IDEA THAT INTERACTIVE ARTEFACTS NEED TO BE USABLE REPRODUCED? Usability is a positive term *per se*. Merely the use of the word usability indicates this; this thing is usable while this is not. The term use quality cannot be used in such a manner[2]; that a ceratin object has use quality says a lot, but not whether it is good, nor whether the specific use quality (not mentioned) was appropriately selected for assessment. Usability, in comparison with use quality, carries with it a strong sense that certain things are negative. For example, usability strives to reduce complexity, where use quality more readily deals with issues of complexity and what quality indicators indicate the goal range of complexity. Or, for that matter, usability strives for coherent interfaces, thus defining incoherent interfaces as bad. The use qualities most related to this would be consonance and dissonance, where it is impossible to say that consonance or dissonance in all cases is better than the other. For use quality there is not an inherent need to deal primarily with positives, nor to reduce negatives.

Given this, it is quite clear that use quality does not reproduce the idea that interactive artefacts need to be usable.

2. Every term risks to be integrated into language use in a manner not intended from the start. The stronger formulation, that *use quality should not be used neither as a positive nor a negative term*, therefore is preferable.

IS THE IDEA THAT INTERACTIVE ARTEFACTS NEED TO BE USABLE REINFORCED? The research performed here reaches wider than usability. It proposes a multi-perspective view instead of the monocultural view of usability. In a way that is a reinforcement of the idea that interactive artefacts need to be usable, but it is also fair to say that it reinforces several other ideas, in conflict or agreement with each other, about what interactive artefacts need to be.

Given this, the partial reinforcement can be used as a tool to further both usability and use quality.

Research process assessment

Transferability

I have shown that within the scope of an organisation the concept and models produced can be transferred between products-in-use and between learning environment set-ups.

Different parts of the results are transferable in different ways into different areas. For instance, surprise/confusion is directly transferable into any kind of notification system with alarms. The alarms are designed to surprise, and analysing what caused the alarm, or what could be done about it, all too often cause confusion. Using these as conscious design considerations could provide a design process better equipped for the realities of use of notification system.

One of the limiting factors for transferability could be usability maturity at a personal and organisational level, or familiarity of working with concepts, rather than definitions.

On the most general level, working with use qualities to guide and assess use as well as design activities regarding interactive artefacts, transferability is good.

Indexicality

Being qualitative research I have tried to clearly express the changes that took place during, in and through the research project. I have also tried to be open about the role and influence the researchers as well as co-researchers and informants have had on the process and on each other.

One weakness has been the researcher's mediating role for the use of the systems under scrutiny. The project group and the co-researchers, most of which have had some previous experience from work at the branches, all took part of written accounts of the use of the systems. Thus, the modelling and their reflections are based not on having seen these systems in use, or these specific use cases. This limits their understanding of the use of the systems to the specific use cases, but enhances the use cases with their experiences from systems in use at the bank.

It is my firm belief that the descriptions given makes it possible to repeat the study, although not replicate it.

Inconcludability

During the course of the research the models and the concept have changed on several occasions. The perspective and assessment of several actors with different interests and horizons, have been brought to bear on the reformulation. It has not been the goal to provide a final model. Other actors will bring their own interpretations.

While seemingly being in constant change, the different interpretations provided throughout the process give a broader and clearer picture of use quality as well as the potential complexity of working with use qualities; the ongoing reformulation on the part of different actors, the different perspectives brought into the process by actors' differing interests, the dynamics provided through modelling, *et cetera*.

Together with these specific learning developers we understood different things than we would have done together with these specific system developers separately. Hopefully everyone can develop the sensitivity and perspective shifting abilities to become proficient use quality assessors.

The selection of informants and development project group participants was a mix between what was provided by project and business realities and circumstances and carefully directed selection by the researchers.

I claim only that the results presented here are provisional in the broader research and practice settings. All attempts to reformulate, conceptualize, corroborate, *et cetera*, are welcomed. Precisely this is one of the fundaments of good qualitative research.

Reflexivity

It is obvious that the inception of this research process was based on a personal interest, not only of the specific question posed, but of performing a specific kind of research; a qualitative redefinition of a field. It is also obvious that the position taken is based on another and a more contemporary philosophy, than is the opposing concept within the field. Ever since early 1994, when the ideas first started to take form, the process of restructuring understanding and production of knowledge has been ongoing.

During the course of the research several other parties interested in the research question at hand have entered the scene, and brought their view upon the ongoing work, both as participants and as significant others. Thus, the downside of reflexivity has been weakened.

The choice of an intervention oriented research method, engaged with development projects managed by a practitioner, also contributed to weaken the effects of reflexivity.

As far as have been possible challenges posed by others and ourselves have been accepted, and in every encounter an openness have been strived for. Of course, group dynamics and other confusions might have been detrimental to this, which I have tried to handle in the best possible way given the circumstances.

All in all, I've tried to explicitly, and implicitly, make the complexity of performing idiographic research with qualitative methods in an action like setting, under the circumstances of this specific case, clear. I have also tried, and I wish for it to show through, communicate the deep engagement for the issues at hand, the creativity of the different working groups, and the high motivation with which the research has been performed since its inception in 1995.

Imorgon kommer något underbart att hända

from sculpture/installation at Linköpings universitet
by Jan Svenungsson

IV.13 Conclusions

The findings regarding the two knowledge interests will here be given in shorthand style, providing as good answers as there are on the general level to the main research questions, thus providing for conclusions of this research endeavour.

What use quality is

Use quality is what characterizes the use of an interactive artefact. It is a pluralistic concept as we understand it from the research performed here. The concept has changed organically during the course of the project. There can be no single definition of specified use qualities which holds over genres, over time, and over organisational boundaries. Several tentative conceptions of use quality will exist in parallel, from time to time they will meet and contribute to each other's development.

Some specific use qualities have been uncovered and dealt with. Surprise and confusion is a conceptual pair tightly intertwined around the situations of use in which they appear and in that they both carry a knowledge interest. Ante-use is what precedes use. It spans from preparations over expectations to other's predictions.

The interactive artefacts play a role not only in the productive use of work, but also in a learning use. The continuous learning use is always present[1] in a sort of suspense. Sometimes it is consciously disregarded, or bracketed, such as when a user continues to work instead of learning from a surprise. The organized learning use, such as that during a course, presumes another set of uses of the interactive artefact; the teacher's, course designer's and simulator builder's use.

Understanding or assessing use qualities depends on a multi-perspective approach. Different actors with different backgrounds and different interests and agendas view and express the use of an artefact in different ways. Without actively taking perspectives, or shifting perspectives, the understanding of use quality will be bound by hidden agendas and the presumed perspectives of the active participants, and their prejudices on each others' perspectives. It seems to be important to share, but not necessarily hold the same, views and perspectives, in order to sucessfully work with use qualities. This can be supported with inclusive design processes, and a more open and sensitive assessment framework for use qualities.

Several empirically and theoretically grounded tentative models of use quality have been formulated during the course of this research, with different levels of detail. It would be fairly easy to restipulate one of the models from the theoretical framework, and call it a synthesis that fits, it wouldn't even be scientifically wrong to do so. But given the pluralism and the multi-perspectivity it would be wrong of me trying to put a synthesized model in front of the variety of models, as if it were a better model.

How learning can foster use quality

Learning fosters use quality in several different ways. The learning environment designers provide a wide range of aspects as important to the use of an interactive artefact, based on their interest in developing people and business together and their position in the value chain as customers (i.e. hired by the procurer not the producer). These aspects could all be used

1. For a discussion on presence in the context of interactive artefacts see Hallnäs & Redström (2002), and Redström (2001).

during development of the artefact. This insight also changed their view on artefacts and on their own possible role in the organisation. They also saw the potential and possibility of designing learning periods with the intent of changing one or several of the use qualities identified. Learning also foster use qualities in the sense that learning can be seen as one use of an interactive artefact, just as teaching is another kind of use. Last, doing research together with learning environment designers shaped both the research process and its outcomes, in that sense learning fostered use quality in terms of the theories and models presented here.

The models of use quality developed consists of a wide and far reaching set of aspects, perspectives and specific use qualities. It is significant that they are loosely structured, but carry their meaning, fit and usefulness from the setting in which the interactive artefacts are used, as opposed to carrying their meaning of producing interactive artefacts. It is interesting that the models bear similarities to several of the extended usability definitions available, apart from the fact that for the models developed the idea of extension has no meaning.

Three of the specific use qualities identified are intrinsically connected to learning to use an interactive artefact. Surprise and confusion both hold possibilities for learning, both as planned and unplanned experiences. One aspect of ante-use is learning to use the artefact.

The artefact as it is, is the everyday learning environment for the users. It becomes a part of micro-level learning environments as well as the more general kinds of learning environments provided by the organisation. In this sense it is not an isolated object, but is highly (but not always well) integrated into an extremely heterogeneous milieu, loosely held together by the way in which the business is organized.

Given that learning environment developers are allowed to play a role in the design of interactive artefacts, they contribute with a different perspective on the use and design of the artefact. Their experiences can add to assessment procedures a more open and sensitive framework based on

use qualities. One such addition would take into account the complex nature and interdependencies between use quality, novice/expert, low-achiever/high-achiever, and low self-efficacy/high self-efficacy.

There seemed to be a difference in understanding and construction of use quality between learning environment designers and system developers, even though they all were from the same organisation. Whether this difference would persist in a longitudinal perspective is hard to foresee.

All in all, I've tried to explicitly, and implicitly, make the beauty and complexity of use quality clear. I am confident that we have reached an advanced and reasonable position for furthering the discussion and development of knowledge about use qualities. I am sure that light has been shed upon what kinds of use qualities an interactive artefact should show to be good or fit.

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APPENDICES

APP I

Questionnaire

The questionnaire used consisted of 35 questions capturing 10 proposed use qualities as well as computer self-efficacy. All questions were in Swedish.

To assess the use qualities, questions in the questionnaire were grouped to form factors/indicators. These groups are presented in TABLE 9. In TABLE 10 the way the use qualities were derived from the indicators are given.

Last, on page 196 the full questionnaire is given. It is reformatted to fit the thesis pages.

Table 9: **The questions to assess computer self efficacy and the 10 use qualities**

Use quality	Questions
Computer self-efficacy Datorrelaterad självtillit	Jag skulle kunna utföra mina arbetsuppgifter genom att använda Word...
	...om det inte fanns någon som under tiden kunde tala om för mig hur jag skulle göra
	...om jag aldrig tidigare använt ett liknande program
	...om jag hade enbart handböckerna som referens
	...om jag hade sett någon annan använda programmet innan jag prövade själv
	...om det fanns någon att ringa och fråga om hjälp om jag kör fast
	...om någon hade hjälpt mig att komma igång
	...om jag hade gott om tid att utföra det arbete programvaran är inköpt för
	...om jag hade enbart den inbyggda hjälpen som stöd
	...om någon först hade visat hur man skall göra
	...om jag tidigare hade använt liknande program för att utföra samma arbetsuppgifter
Relevance of use Relevans	Det här programmet verkar störa det sätt på vilket jag normalt vill utföra mitt arbete
	Jag skulle inte vilja använda detta program varje dag
	Det är lätt att få det här programmet att göra precis det man vill
	Jag kan utföra mitt arbete på ett bra sätt med detta program
	Med det här programmet kan man utföra arbetsuppgifter på ett rättframt sätt
Efficient task Effektiv uppgiftslösning	Det här programmet är långsamt
	Jag kan effektivt utföra mina arbetsuppgifter med detta program
Problem-free task Problemfritt uppgiftslösande	Om det här programmet hakar upp sig är det inte enkelt att starta om där man slutade
	Det här programmet beter sig emellanåt på ett obegripligt sätt
	Vid de flesta tillfällen då jag använder det här programmet behöver jag använda hjälpen, manualen, eller fråga någon
Correct task Korrekt uppgiftslösning	Med det här programmet kan man utföra arbetsuppgifter på ett rätttframt sätt
	Jag kan utföra mina arbetsuppgifter med ett bra resultat

Table 9: **The questions to assess computer self efficacy and the 10 use qualities**

Use quality	Questions
Motivation to use Motivation att använda	Jag skulle inte vilja använda detta program varje dag
	Jag kommer aldrig att lära mig använda allt det som programmet erbjuder
	Jag prioriterar inte datorn som första hjälpmedel i mina arbetsuppgifter
	Flera arbetsuppgifter är nödvändiga att lösa med detta system
Motivation to use for more qualified tasks Motivation att använda för mer kvalificerade arbetsuppgifter	Jag tror att jag kommer att behöva använda datorn för mer kvalificerade arbetsuppgifter allteftersom
	Ju mer kvalificerade en arbetsuppgift är desto mindre ser jag datorn som ett hjälpmedel
The time spent is well spent time Tiden känns väl använd	Jag upplever att tiden jag arbetar med datorn är väl utnyttjad tid
	Datorn har inte medfört något merarbete
	Genom att använda datorn i arbetet får jag mer tid över för kunden
The time spent with customers is qualitatively better Tiden tillsammans med kunder ger högra kvalitet i kundmötet	Genom att använda datorn i arbetet har jag kunnat ägna mig på ett bättre sätt åt kundens problem
	Datorn tar inte onödig uppmärksamhet från kundarbetet och kundrelationer
Perceived safe use Upplevd säkert bruk	Det är lätt att få det här programmet att göra precis det man vill
	Jag känner mig säkrare om jag bara använder sådant i programmet som jag redan känner till
Perceived shortcomings Upplevda brister	Några stora brister hos systemet bidrar till att det det blir onödigt komplicerat att utföra vissa arbetsuppgifter
	Systemet innehåller varken stora eller små brister
	På det stora hela är jag nöjd med systemet

The use quality indicators, apart from computer self-efficacy, were derived from the questions as follows:

Table 10: **Calculations for the 10 use qualities**

Use quality	Indicator
Relevance of use	bk1+bk2-bk3-bk4-bk8
Efficient task	bk5-bk6
Problem-free task	bk7+bk11+bk20
Correct task	-bk8-bk9

Table 10: **Calculations for the 10 use qualities**

Use quality	Indicator
Motivation to use	bk2+bk10+bk12-bk13
Motivation to use for more qualified tasks	-bk14+bk22
The time spent is well spent time	-bk15-bk16-bk18
The time spent with customers is qualitatively better	-bk19-bk21
Perceived safe use	-bk23-bk3
Perceived shortcomings	bk17-bk24-bk25

The questionnaire was fitted onto a single sheet of paper. Below the questionnaire is presented, although on another page format. The questions are not translated into English, because the questionnaire was in Swedish.

Ni skall få en ny programvara för att kunna skriva brev och fax. Följande frågor vill jag att du besvarar med den programvaran som fokus. Frågorna handlar om under vilka omständigheter du skulle kunna använda den nya programvaran. För varje fråga markera om du tror att du skulle kunna utföra dina arbetsuppgifter med programvaran. För varje fråga du svarar JA så ber jag dig också gradera hur säker du är över din bedömning. Längst åt vänster kryssar du om du inte alls är säker, och längst åt höger om du är absolut säker på din bedömning.

	Jag skulle kunna utföra mina arbetsuppgifter genom att använda Word 6 om någon gav mig instruktioner steg för steg.	JA ❑ NEJ ❑	1 2 3 4 5 6 7 8 9 10

Detta exempel visar en person som är ganska säker på att hon skulle kunna utföra sitt arbete om hon fick hjälp genom stegvisa instruktioner.

Jag skulle kunna utföra mina arbetsuppgifter genom att använda Word...

			Inte alls säker								Helt säker
1.	...om det inte fanns någon som under tiden kunde tala om för mig hur jag skulle göra	JA ❑ NEJ ❑	1	2	3	4	5	6	7	8	9	10
2.	...om jag aldrig tidigare använt ett liknande program	JA ❑ NEJ ❑	1	2	3	4	5	6	7	8	9	10
3.	...om jag hade enbart hand-böckerna som referens	JA ❑ NEJ ❑	1	2	3	4	5	6	7	8	9	10
4.	...om jag hade sett någon annan använda programmet innan jag prö-vade själv	JA ❑ NEJ ❑	1	2	3	4	5	6	7	8	9	10
5.	...om det fanns någon att ringa och fråga om hjälp om jag kör fast	JA ❑ NEJ ❑	1	2	3	4	5	6	7	8	9	10

Jag skulle kunna utföra mina arbetsuppgifter genom att använda Word...

			Inte alls säker									Helt säker
6.	...om någon hade hjälpt mig att komma igång	JA ❑ NEJ ❑	1	2	3	4	5	6	7	8	9	10
7.	...om jag hade gott om tid att utföra det arbete program-varan är inköpt för	JA ❑ NEJ ❑	1	2	3	4	5	6	7	8	9	10
8.	...om jag hade enbart den inbyggda hjäl-pen som stöd	JA ❑ NEJ ❑	1	2	3	4	5	6	7	8	9	10
9.	...om någon först hade visat hur man skall göra	JA ❑ NEJ ❑	1	2	3	4	5	6	7	8	9	10
10.	...om jag tidi-gare hade använt lik-nande program för att utföra samma arbets-uppgifter	JA ❑ NEJ ❑	1	2	3	4	5	6	7	8	9	10

För att få ytterligare kunskap om hur användbart du upplever det testade systemet skulle jag vilja att du tar ställning till följande 25 påståenden.

Ställ dig frågan om du kan hålla med eller inte om påståendet och kryssa i hur starkt. Är du osäker kryssa inte alls.

	Påstående	Håller med			Håller inte med		
bk1	Det här programmet verkar störa det sätt på vilket jag normalt vill utföra mitt arbete	❑	❑	❑	❑	❑	❑
bk2	Jag skulle inte vilja använda detta program varje dag	❑	❑	❑	❑	❑	❑
bk3	Det är lätt att få det här programmet att göra precis det man vill	❑	❑	❑	❑	❑	❑
bk4	Jag kan utföra mitt arbete på ett bra sätt med detta program	❑	❑	❑	❑	❑	❑
bk5	Det här programmet är långsamt	❑	❑	❑	❑	❑	❑
bk6	Jag kan effektivt utföra mina arbetsuppgifter med detta program	❑	❑	❑	❑	❑	❑
bk7	Om det här programmet hakar upp sig är det inte enkelt att starta om där man slutade	❑	❑	❑	❑	❑	❑
bk8	Med det här programmet kan man utföra arbetsuppgifter på ett rättframt sätt	❑	❑	❑	❑	❑	❑
bk9	Jag kan utföra mina arbetsuppgifter med ett bra resultat	❑	❑	❑	❑	❑	❑
bk10	Jag kommer aldrig att lära mig använda allt det som programmet erbjuder	❑	❑	❑	❑	❑	❑
bk11	Det här programmet beter sig emellanåt på ett obegripligt sätt	❑	❑	❑	❑	❑	❑

	Påstående	Håller med			Håller inte med		
bk12	Jag prioriterar inte datorn som första hjälpmedel i mina arbetsuppgifter	❑	❑	❑	❑	❑	❑
bk13	Flera arbetsuppgifter är nödvändiga att lösa med detta system	❑	❑	❑	❑	❑	❑
bk14	Jag tror att jag kommer att behöva använda datorn för mer kvalificerade arbetsuppgifter allteftersom	❑	❑	❑	❑	❑	❑
bk15	Jag upplever att tiden jag arbetar med datorn är väl utnyttjad tid	❑	❑	❑	❑	❑	❑
bk16	Datorn har inte medfört något merarbete	❑	❑	❑	❑	❑	❑
bk17	Några stora brister hos systemet bidrar till att det det blir onödigt komplicerat att utföra vissa arbetsuppgifter	❑	❑	❑	❑	❑	❑
bk18	Genom att använda datorn i arbetet får jag mer tid över för kunden	❑	❑	❑	❑	❑	❑
bk19	Genom att använda datorn i arbetet har jag kunnat ägna mig på ett bättre sätt åt kundens problem	❑	❑	❑	❑	❑	❑
bk20	Vid de flesta tillfällen då jag använder det här programmet behöver jag använda hjälpen, manualen, eller fråga någon	❑	❑	❑	❑	❑	❑
bk21	Datorn tar inte onödig uppmärksamhet från kundarbetet och kundrelationer	❑	❑	❑	❑	❑	❑
bk22	Ju mer kvalificerade en arbetsuppgift är desto mindre ser jag datorn som ett hjälpmedel	❑	❑	❑	❑	❑	❑

	Påstående	Håller med					Håller inte med
bk23	Jag känner mig säkrare om jag bara använder sådant i programmet som jag redan känner till	❑	❑	❑	❑	❑	❑
bk24	Systemet innehåller varken stora eller små brister	❑	❑	❑	❑	❑	❑
bk25	På det stora hela är jag nöjd med systemet	❑	❑	❑	❑	❑	❑

APP 2

Data from Aspect 1

On the following pages descriptive statistics for all ten use qualities plus computer self efficacy and the total use quality studied in III.07 EXPLORING USE OF WORD will be presented.

For every factor the mean and median is calculated. For computer self-efficacy the magnitude and the strength is calculated, for the other factors the sum (equalling the strength) is calculated. A Wilcoxon Signed Ranks test is performed for every factor, as is a paired t-test.

Computer self efficacy

Computer self-efficacy is how confident a user is to achieve a certain goal by using a computer

Table 11: **Computer self efficacy before training period**

CSE	Median	Mean	Magnitude	Strength
AR	7,00	6,40	9	64
YH	4,00	4,40	8	44
SS	7,50	7,70	10	77
MS	10,00	9,40	10	94
YY	6,50	5,20	9	52
JL	8,00	7,20	10	72
GS	5,00	4,20	10	42
GROUP	7,00	6,36	66	445

Table 12: **Computer self efficacy after training period**

CSE	Median	Mean	Magnitude	Strength
AR	9,00	8,20	10	82
YH	8,00	7,60	10	76
SS	9,00	8,90	10	89
MS	9,50	9,20	10	92
YY	7,50	7,00	10	70
JL	7,00	6,90	10	69
GS	6,50	6,00	9	60
GROUP	8,00	7,69	69	538

Table 13: **Wilcoxon signed rank test, CSE**

Wilcoxon, CSE	sign	d(A-B)	rank d	rank +	rank -
AR	-1	18	5	0	5
YH	-1	32	7	0	7
SS	-1	12	3	0	3
MS	1	2	1	1	0
YY	-1	18	5	0	5
JL	1	3	2	2	0
GS	-1	18	5	0	5
Total				3	25
				W	3
				N	7
				single	0,05
				double	0,1

Table 14: **Paired T-test for means**

T-test, CSE	Strength, pre	Strength, post
Mean	63,57	76,86
Variance	359,95	132,81
Observations	7	7
Pearson Correlation	0,78	
Hypothesized Mean Difference	0	
df	6	
t Stat	-2,84	
P(T<=t) one-tail	0,015	
t Critical one-tail	1,94	
P(T<=t) two-tail	0,029	
t Critical two-tail	2,45	

Use quality

This is the overall use quality measure

Table 15: **Use quality before training period**

Use quality	Median	Mean	Strength
AR	2,00	2,92	73,00
YH	3,00	3,32	83,00
SS	2,00	2,96	74,00
MS	3,00	3,20	80,00
YY	2,00	3,04	76,00
JL	2,00	3,12	78,00
GS	4,00	4,00	100,00
GROUP	3,00	3,22	564

Table 16: **Use qualityafter training period**

Use quality	Median	Mean	Strength
AR	1,00	2,64	66,00
YH	2,00	3,12	78,00
SS	2,00	2,88	72,00
MS	3,00	3,40	85,00
YY	3,00	2,76	69,00
JL	2,00	3,04	76,00
GS	4,00	3,76	94,00
GROUP	3,00	3,09	540

Table 17: **Wilcoxon signed rank test, use quality**

Wilcoxon, use quality	sign	d(A-B)	rank d	rank +	rank -
AR	1	7	6,5	6,5	0
YH	1	5	3,5	3,5	0
SS	1	2	1,5	1,5	0
MS	-1	5	3,5	0	3,5
YY	1	7	6,5	6,5	0
JL	1	2	1,5	1,5	0
GS	1	6	5	5	0
Total				24,5	3,5
				W	3,5
				N	7
				single	0,05
				double	0,1

Table 18: **Paired T-test for means**

T-test, use quality	Strength, pre	Strength, post
Mean	80,57	77,14
Variance	85,29	94,14
Observations	7	7
Pearson Correlation	0,90	
Hypothesized Mean Difference	0	
df	6	
t Stat	2,12	
P(T<=t) one-tail	0,039	
t Critical one-tail	1,94	
P(T<=t) two-tail	0,078	
t Critical two-tail	2,45	

Relevant use

The users should experience the use of Word as being relevant to their work

Table 19: **Relevance before training period**

Relevance	Median	Mean	Strength
AR	4,00	3,80	19,00
YH	3,00	4,00	20,00
SS	3,00	3,20	16,00
MS	2,00	3,00	15,00
YY	3,00	3,80	19,00
JL	2,00	3,60	18,00
GS	5,00	4,80	24,00
GROUP	3,00	3,74	131,00

Table 20: **Relevance after training period**

Relevance	Median	Mean	Strength
AR	4,00	3,60	18,00
YH	3,00	3,80	19,00
SS	2,00	2,80	14,00
MS	2,00	3,40	17,00
YY	2,00	3,00	15,00
JL	2,00	3,60	18,00
GS	5,00	4,20	21,00
GROUP	3,00	3,49	122,00

Table 21: **Wilcoxon signed rank test, relevance**

Wilcoxon, relevance	sign	d(A-B)	rank d	rank +	rank -
AR	1	1	1,5	1,5	1,5
YH	1	1	2	2	2
SS	1	2	3,5	3,5	3,5
MS	-1	2	3,5	0	0
YY	1	4	6	6	6
GS	1	3	5	5	5
JL	0	0	0	0	0
Total				18	18
				W	3,5
				N	6
				single	non
				double	non (0,16)

Table 22: **Paired T-test for means**

T-test, relevance	Strength, pre	Strength, post
Mean	18,71	17,43
Variance	8,57	5,62
Observations	7	7
Pearson Correlation	0,74	
Hypothesized Mean Difference	0	
df	6	
t Stat	1,72	
P(T<=t) one-tail	0,068	
t Critical one-tail	1,94	
P(T<=t) two-tail	0,14	
t Critical two-tail	2,45	

Efficient task

The users should be able to solve their tasks within a short period of time.

Table 23: **Efficiency before training period**

Efficiency	Median	Mean	Strength
AR	3,50	3,50	7,00
YH	2,50	2,50	5,00
SS	3,00	3,00	6,00
MS	2,00	2,00	4,00
YY	4,00	4,00	8,00
JL	5,00	5,00	10,00
GS	4,00	4,00	8,00
GROUP	3,00	2,50	48,00

Table 24: **Efficiency after training period**

Efficiency	Median	Mean	Strength
AR	3,50	3,50	7,00
YH	3,50	3,50	7,00
SS	3,50	3,50	7,00
MS	3,50	3,50	7,00
YY	3,50	3,50	7,00
JL	4,00	4,00	8,00
GS	5,00	5,00	10,00
GROUP	5,00	2,29	53,00

Table 25: **Wilcoxon signed rank test, CSE**

Wilcoxon, efficiency	sign	d(A-B)	rank d	rank +	rank -
AR	-1	2	4	0	4
YH	-1	1	1,5	0	1,5
SS	-1	3	6	0	6
MS	1	1	1,5	1,5	0
YY	1	2	4	4	0
GS	-1	2	4	0	4
JL	0	0	0	0	0
Total				5,5	15,5
				W	5,5
				N	6
				single	non
				double	non

Table 26: **Paired T-test for means**

T-test, efficiency	Strength, pre	Strength, post
Mean	6,86	7,57
Variance	4,14	1,29
Observations	7	7
Pearson Correlation	0,47	
Hypothesized Mean Difference	0	
df	6	
t Stat	-1,05	
P(T<=t) one-tail	0,17	
t Critical one-tail	1,94	
P(T<=t) two-tail	0,33	
t Critical two-tail	2,45	

Problem free task

The users should be able to solve their tasks with few problems or errors

Table 27: **Problem free before training period**

Problem free	Median	Mean	Strength
AR	5,00	4,67	14,00
YH	4,00	3,67	11,00
SS	5,00	4,00	12,00
MS	3,00	3,33	10,00
YY	3,00	3,00	9,00
JL	5,00	4,33	13,00
GS	3,00	3,33	10,00
GROUP	3,00	2,29	79

Table 28: **Problem free after training period**

Problem free	Median	Mean	Strength
AR	5,00	3,67	11,00
YH	5,00	4,00	12,00
SS	6,00	4,00	12,00
MS	5,00	4,67	14,00
YY	3,00	3,67	11,00
JL	5,00	4,33	13,00
GS	4,00	4,00	12,00
GROUP	3,00	2,43	85

Table 29: **Wilcoxon signed rank test, problem free**

Wilcoxon, problem free	sign	d(A-B)	rank d	rank +	rank -
YH	-1	1	1	0	1
MS	-1	4	5	0	5
YY	-1	2	2,5	0	2,5
GS	-1	2	2,5	0	2,5
AR	1	3	4	4	0
SS	0	0	0	0	0
JL	0	0	0	0	0
Total				4	11
				W	4
				N	5
				single	non
				double	non

Table 30: **Paired T-test for means**

T-test, problem free	Strength, pre	Strength, post
Mean	11,29	12,14
Variance	3,24	1,14
Observations	7	7
Pearson Correlation	-0,11	
Hypothesized Mean Difference	0	
df	6	
t Stat	-1,03	
P(T<=t) one-tail	0,17	
t Critical one-tail	1,94	
P(T<=t) two-tail	0,34	
t Critical two-tail	2,45	

Correctness

The users should be able to solve their tasks producing a correct result

Table 31: **Correctness before training period**

Correctness	Median	Mean	Strength
AR	2,50	2,50	5,00
YH	2,50	2,50	5,00
SS	3,50	3,50	7,00
MS	2,00	2,00	4,00
YY	2,50	2,50	5,00
JL	2,00	2,00	4,00
GS	3,00	3,00	6,00
GROUP	2,50	2,57	36,00

Table 32: **Correctness after training period**

Correctness	Median	Mean	Strength
AR	1,00	1,00	2,00
YH	2,50	2,50	5,00
SS	2,00	2,00	4,00
MS	2,00	2,00	4,00
YY	0,50	0,50	1,00
JL	2,00	2,00	4,00
GS	2,00	2,00	4,00
GROUP	2,00	1,71	24,00

Table 33: **Wilcoxon signed rank test, correctness**

Wilcoxon, correctness	sign	d(A-B)	rank d	rank +	rank -
YY	1	4	4	4	0
GS	1	2	1	1	0
AR	1	3	2,5	2,5	0
SS	1	3	2,5	2,5	0
YH	0	0	0	0	0
MS	0	0	0	0	0
JL	0	0	0	0	0
Total				10	0
				W	0
				N	4
				single	non
				double	non

Table 34: **Paired T-test for means**

T-test, correctness	Strength, pre	Strength, post
Mean	5,14	3,43
Variance	1,14	1,95
Observations	7	7
Pearson Correlation	0,06	
Hypothesized Mean Difference	0	
df	6	
t Stat	2,66	
P(T<=t) one-tail	0,019	
t Critical one-tail	1,94	
P(T<=t) two-tail	0,037	
t Critical two-tail	2,45	

Willingness to use

The course should increase the user's will to use Word in their work

Table 35: **Will to use before training period**

Will to use	Median	Mean	Strength
AR	3,50	3,50	14,00
YH	6,00	5,00	20,00
SS	2,50	2,50	10,00
MS	4,50	4,25	17,00
YY	3,00	3,25	13,00
JL	4,50	4,25	17,00
GS	4,50	4,50	18,00
GROUP	3,00	3,89	36,00

Table 36: **Will to use after training period**

Will to use	Median	Mean	Strength
AR	3,50	4,75	19,00
YH	5,50	4,50	18,00
SS	3,00	3,00	12,00
MS	4,00	3,75	15,00
YY	4,00	3,75	15,00
JL	4,50	4,25	17,00
GS	5,00	4,50	18,00
GROUP	5,00	4,07	24,00

Table 37: **Wilcoxon signed rank test, will to use**

Wilcoxon, will to use	sign	d(A-B)	rank d	rank +	rank -
YY	-1	2	2,5	0	2,5
AR	-1	5	5	0	5
SS	-1	2	2,5	0	2,5
YH	1	2	2,5	2,5	0
MS	1	2	2,5	2,5	0
GS	0	0	0	0	0
JL	0	0	0	0	0
Total				5	10
				W	5
				N	5
				single	non
				double	non

Table 38: **Paired T-test for means**

T-test, will to use	Strength, pre	Strength, post
Mean	15,57	16,29
Variance	11,62	5,90
Observations	7	7
Pearson Correlation	0,68	
Hypothesized Mean Difference	0	
df	6	
t Stat	-0,76	
P(T<=t) one-tail	0,24	
t Critical one-tail	1,94	
P(T<=t) two-tail	0,48	
t Critical two-tail	2,45	

Willingness to use for more qualified tasks

The course should also motivate them to use it for more qualified tasks

Table 39: **Qualified tasks before training period**

Qualified tasks	Median	Mean	Strength
AR	3,50	3,50	7,00
YH	3,50	3,50	7,00
SS	2,00	2,00	4,00
MS	3,00	3,00	6,00
YY	3,50	3,50	7,00
JL	3,50	3,50	7,00
GS	3,50	3,50	7,00
GROUP	2,00	3,21	45

Table 40: **Qualified tasks after training period**

Qualified tasks	Median	Mean	Strength
AR	1,00	1,00	2,00
YH	3,50	3,50	7,00
SS	1,50	1,50	3,00
MS	3,00	3,00	6,00
YY	4,00	4,00	8,00
JL	3,50	3,50	7,00
GS	3,50	3,50	7,00
GROUP	2,00	2,86	40

Table 41: **Wilcoxon signed rank test, qualified tasks**

Wilcoxon, qualified tasks	sign	d(A-B)	rank d	rank +	rank -
YY	1	5	3	3	0
AR	1	1	1,5	1,5	0
SS	-1	1	1,5	0	1,5
YH	0	0	0	0	0
MS	0	0	0	0	0
GS	0	0	0	0	0
JL	0	0	0	0	0
Total				4,5	1,5
				W	1,5
				N	3
				single	non
				double	non

Table 42: **Paired T-test for means**

T-test, qualilfied tasks	Strength, pre	Strength, post
Mean	6,43	5,71
Variance	1,29	5,24
Observations	7	7
Pearson Correlation	0,50	
Hypothesized Mean Difference	0	
df	6	
t Stat	0,96	
P(T<=t) one-tail	0,19	
t Critical one-tail	1,94	
P(T<=t) two-tail	0,38	
t Critical two-tail	2,45	

Well spent time

The time in front of the computer should be experienced as well spent

Table 43: **Well spent time before training period**

Well spent time	Median	Mean	Strength
AR	1,00	1,33	4,00
YH	1,00	1,67	5,00
SS	2,00	2,00	6,00
MS	2,00	1,67	5,00
YY	1,00	1,00	3,00
JL	2,00	1,67	5,00
GS	5,00	4,00	12,00
GROUP	2,00	1,90	40

Table 44: **Well spent time after training period**

Well spent time	Median	Mean	Strength
AR	1,00	1,00	3,00
YH	1,00	1,00	3,00
SS	2,00	2,00	6,00
MS	2,00	2,00	6,00
YY	1,00	1,33	4,00
JL	1,00	1,33	4,00
GS	3,00	3,00	9,00
GROUP	1,00	1,67	35

Table 45: **Wilcoxon signed rank test, well spent time**

Wilcoxon, well spent time	sign	d(A-B)	rank d	rank +	rank -
AR	1	1	2,5	2,5	0
YH	1	2	5	5	0
MS	-1	1	2,5	0	2,5
YY	-1	1	2,5	0	2,5
GS	1	3	6	6	0
JL	1	1	2,5	2,5	0
SS	0	0	0	0	0
Total				16	5
				W	5
				N	6
				single	non
				double	non

Table 46: **Paired T-test for means**

T-test, well spent time	Strength, pre	Strength, post
Mean	5,71	5
Variance	8,57	4,67
Observations	7	7
Pearson Correlation	0,87	
Hypothesized Mean Difference	0	
df	6	
t Stat	1,26	
P(T<=t) one-tail	0,13	
t Critical one-tail	1,94	
P(T<=t) two-tail	0,25	
t Critical two-tail	2,45	

Time with customers qualitatively better

The time in front of the computer should be experienced as well spent

Table 47: **Customer quality before training period**

Customer quality	Median	Mean	Strength
AR	1,50	1,50	3,00
YH	2,50	2,50	5,00
SS	2,00	2,00	4,00
MS	3,50	3,50	7,00
YY	1,00	1,00	2,00
JL	2,50	2,50	5,00
GS	3,50	3,50	7,00
GROUP	2,00	2,36	33

Table 48: **Customer quality after training period**

Customer quality	Median	Mean	Strength
AR	1,00	1,00	2,00
YH	1,00	1,00	2,00
SS	3,50	3,50	7,00
MS	4,00	4,00	8,00
YY	0,00	0,00	0,00
JL	1,50	1,50	3,00
GS	2,50	2,50	5,00
GROUP	1,50	1,93	27

Table 49: **Wilcoxon signed rank test, customer quality**

Wilcoxon, customer quality	sign	d(A-B)	rank d	rank +	rank -
AR	1	1	1,5	1,5	0
YH	1	3	6	6	0
MS	-1	1	1,5	0	1,5
YY	1	2	4	4	0
GS	1	2	4	4	0
JL	1	2	4	4	0
SS	-1	3	6	0	6
Total				19,5	7,5
				W	7,5
				N	7
				single	non
				double	non

Table 50: **Paired T-test for means**

T-test, customer quality	Strength, pre	Strength, post
Mean	4,71	3,86
Variance	3,57	8,48
Observations	7	7
Pearson Correlation	0,69	
Hypothesized Mean Difference	0	
df	6	
t Stat	1,07	
P(T<=t) one-tail	0,16	
t Critical one-tail	1,94	
P(T<=t) two-tail	0,32	
t Critical two-tail	2,45	

Safe use

The user should feel confident and safe using the system

Table 51: **Safe use before training period**

Safe use	Median	Mean	Strength
AR	2,50	2,50	5,00
YH	3,00	3,00	6,00
SS	2,00	2,00	4,00
MS	2,00	2,00	4,00
YY	3,50	3,50	7,00
JL	2,00	2,00	4,00
GS	3,50	3,50	7,00
GROUP	2,00	3,07	37

Table 52: **Safe use after training period**

Safe use	Median	Mean	Strength
AR	2,50	2,50	5,00
YH	3,50	3,50	7,00
SS	2,00	2,00	4,00
MS	2,00	2,00	4,00
YY	3,50	3,50	7,00
JL	2,00	2,00	4,00
GS	4,00	4,00	8,00
GROUP	2,00	3,00	39

Table 53: **Wilcoxon signed rank test, safe use**

Wilcoxon, safe use	sign	d(A-B)	rank d	rank +	rank -
GS	-1	1	1	0	1
YH	-1	1	1	0	1
MS	0	0	0	0	0
YY	0	0	0	0	0
AR	0	0	0	0	0
JL	0	0	0	0	0
SS	0	0	0	0	0
Total				0	2
				W	0
				N	2
				single	non
				double	non

Table 54: **Paired T-test for means**

T-test, safe use	Strength, pre	Strength, post
Mean	5,29	5,57
Variance	1,90	2,95
Observations	7	7
Pearson Correlation	0,97	
Hypothesized Mean Difference	0	
df	6	
t Stat	-1,55	
P(T<=t) one-tail	0,086	
t Critical one-tail	1,94	
P(T<=t) two-tail	0,17	
t Critical two-tail	2,45	

Perceived shortcomings

The system should not be experienced as one having a lot of shortcomings

Table 55: **Shortcomings before training period**

Shortcomings	Median	Mean	Strength
AR	1,00	2,33	7,00
YH	2,00	2,67	8,00
SS	5,00	4,33	13,00
MS	4,00	4,33	13,00
YY	4,00	3,67	11,00
JL	0,00	0,33	1,00
GS	4,00	4,00	12,00
GROUP	4,00	3,10	65

Table 56: **Shortcomings after training period**

Shortcomings	Median	Mean	Strength
AR	1,00	2,67	8,00
YH	2,00	3,00	9,00
SS	1,00	2,67	8,00
MS	2,00	3,33	10,00
YY	2,00	2,67	8,00
JL	2,00	2,00	6,00
GS	4,00	3,67	11,00
GROUP	2,00	2,86	60

Table 57: **Wilcoxon signed rank test, shortcomings**

Wilcoxon short-comings	sign	d(A-B)	rank d	rank +	rank -
AR	-1	1	2	0	2
YH	-1	1	2	0	2
MS	1	3	4,5	4,5	0
YY	1	3	4,5	4,5	0
GS	1	1	2	2	0
JL	-1	5	6,5	0	6,5
SS	1	5	6,5	6,5	0
Total				17,5	10,5
				W	10,5
				N	7
				single	non
				double	non

Table 58: **Paired T-test for means**

T-test shortcomings	Strength, pre	Strength, post
Mean	9,29	8,57
Variance	18,9	2,62
Observations	7	7
Pearson Correlation	0,73	
Hypothesized Mean Difference	0	
df	6	
t Stat	0,56	
P(T<=t) one-tail	0,30	
t Critical one-tail	1,94	
P(T<=t) two-tail	0,59	
t Critical two-tail	2,45	