User involvement: A review of the benefits and challenges

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Abstract. User involvement is a widely accepted principle in development of usable systems. However, it is a vague concept covering many approaches. This study first clarifies the nature of user involvement and its expected benefits, and secondly reviews three streams of research, to evaluate the benefits and problems of varied user involvement approaches in practice. The particular focus of this study is on the early activities in the development process. An analysis of the literature suggests that user involvement has generally positive effects, especially on user satisfaction, and some evidence exists to suggest that taking users as a primary information source is an effective means of requirements capture. However, the role of users must be carefully considered and more cost-efficient practices are needed for gathering users' implicit needs and requirements in real product development contexts.

1. Introduction

The goal of user-centred design is the development of usable systems (Gould and Lewis 1985, Karat 1997). One of the principles of user-centred design is the early and continual focus on users, and it is generally agreed that usability is achieved through the involvement of potential users in system design (Karat 1997, Wilson *et al*. 1997, Bekker and Long 2000).

As user needs and use contexts became increasingly important in system development, ISO 13407 (1999) recommends the active involvement of users for understanding user and task requirements. Karat (1997) describes it in this way: 'We don't consider usability as limited to the display and keyboard interface between human and machine, but rather we recognise that it encompasses how any artefact fits into a complex work or home environment'. Thus, it is apparent that documents are insufficient as sources of information and direct contact with users is crucial in order to understand the various contexts of use. Moreover, in theory, user involvement is most efficient and influential in the early stages of system development as the cost involved in making changes increases during system development (cf. Ehrlich and Rohn 1994, Noyes *et al*. 1996).

On the other hand, a clear definition of user involvement is lacking. It has been used synonymously with 'focus on users' (Wilson *et al*. 1997), 'consulting end–users' (Noyes *et al*. 1996), 'contacting with system users' (Grudin 1991a), and 'participation of users' (Heinbokel *et al*. 1996). User involvement can be seen to be a general term describing direct contact with users and covering many approaches. For example, in participatory design, users take active roles in many design activities, but in other approaches users are involved as providers of information, commentators or objects for observations. The level of user involvement can be broadly characterized as being somewhere on the continuum from informative, through consultative to participative (Damodaran 1996).

One of the difficulties in involving users and understanding user requirements is that part of the users' knowledge has become tacit through automation (Wood 1997). In well-learned tasks, much of the relevant knowledge is no longer consciously available for the person and everyday self-evidences are difficult to articulate. Thus, the type and level of user involvement need to be carefully considered. A promising approach is to perform field studies, whereby qualitative methods are used to study users and their activities in their own environment (cf. Bly 1997, Wixon 1995). Users do not need explicitly to articulate their needs, but the underlying problems and possibilities are understood by studying the future context of use.

Even if user involvement is generally approved, research into its efficiency tends to be varied and

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fragmented. For example, Clement and Van den Besselaar (1993) found in their retrospective look at participatory design projects that there were no systematic surveys of these experiences and that the projects did not adequately reflect the longitudinal aspect of their course. Clement and Van den Besselaar (1993) contacted the authors of these reports and asked them to complete a short open-ended questionnaire in order to bring the findings up-to-date. They reviewed 10 projects. The results were somewhat contradictory and showed that user participation does not necessarily lead to users' more positive attitudes toward the technology or market success.

On the other hand, the benefits of usability engineering have been clearly demonstrated (Bias and Mayhew 1994, Karat 1997). In general, for a given project the cost-benefit analysis identifies the costs associated with the usability work for the project and attempts to quantify the potential sources of benefit. The difference between the costs and the benefits is used to demonstrate the value that usability engineering brought to a project (Mayhew and Mantei 1994).

However, Lund (1997) argues that the importance of matching design with user need should be emphasised. Indeed, cost-benefit analyses are generally based on usability evaluation, but the cost-effectiveness of understanding user needs is difficult to evaluate. For example, the case of Digital Equipment Corporation (Wixon and Jones 1996) is an often-referred example of cost-benefit analysis that supports early user involvement. A baseline new product designed with little involvement by human factors professionals experienced disappointingly low initial sales. The second version of the product was developed with extensive involvement by usability professionals. Wixon and Jones (1996) claimed that their methods had a great effect on the product's commercial success, and indeed sales exceeded predictions by 30 to 60%. As a variety of usability techniques were used in the Digital Equipment Corporation case study, no specific grounds or mechanisms for the improvement could be shown.

New approaches such as field studies appear attractive, but the real benefits and costs of such approaches should be considered. The paper of Curtis *et al.* (1999) is one of the very few which thoroughly cover reporting the costs of field studies. They found that their project made a significant contribution to a large organization's customer understanding, but the amount of data to be analysed and represented was large. They spent as many as 50 engineer months and $65 000 in gathering and analysing data.

The purpose of this study is to improve the understanding of early user involvement and its worth in practice. User involvement is a vague concept covering many approaches. All these approaches may have varied benefits and challenges. In this study, the main approaches are identified and their benefits and challenges are reviewed. Information about users and their needs is needed in the early stages of system development, but what kind of user involvement could uncover this kind of informal and non-verbal information? Most literature on user involvement concerns user involvement throughout all the phases of the lifecycle, however this article focuses on what is known about early involvement and then what is known about user involvement in general.

The first section identifies the different approaches to user involvement and clarifies expected benefits. The next section reviews and organizes the literature to evaluate the benefits and problems of user involvement. The literature is organized according to three research streams: field studies, qualitative, and quantitative research. The article concludes with a summary and evaluation of the expected benefits of user involvement according to the research streams and different approaches.

1.1. *Approaches to user involvement*

It was stated earlier that user involvement has been loosely translated as 'direct contact with users' thus covering many approaches. For example, Muller *et al.* (1997) list 61 'participatory' practices including different system development approaches like Joint Application Design 'JAD' (Carmel *et al.* 1993), Soft System Methodology (SSM) (Checkland and Scholes 1990), and ETHICS (Mumford 1993).

Bekker and Long (2000) reviewed the similarities and differences between five of these 'practices'. They evaluated the differences in user role, developer role, user control, user involvement rationale, timing, and process in order to enable designers to compare and choose between various design approaches. However, they did not compare the usefulness or effectiveness of these approaches, possibly because this information is not available. This makes it difficult to choose rationally between the varied system development approaches. In addition, the approaches do not always tell how to implement user involvement in practice. Bekker and Long (2000), for example, found that SSM and JAD are less explicit about how to select and involve an appropriate set of users.

So, what is the role of system development approaches in user involvement? Can we first of all understand the phenomenon of user involvement and its effects? How should user involvement be implemented in practice? If we try to classify the main approaches to user involvement instead of particular development approaches, we may suggest that the main approaches are user-centred design, participatory design, ethnography, and contextual design. For example, these approaches are represented in Readings in Human-Computer Interaction-book (Baecker *et al.* 1995), and the latter three are considered as frameworks of field research by Wixon and Ramey (1996).

The roots and methods of the approaches are closely linked and most of the approaches can be found in the 'Participatory Design' book edited by Schuler and Namioka (1993). In addition, task analysis can involve users (see Diaper 1989, Johnson 1989, Hackos and Redish 1998). All these approaches include a rationale explaining why to involve users and a methodology on how to involve users. Table 1 demonstrates the differences for the user involvement approaches.

The goal of user-centred design is the development of useful and usable products. There appears to be no agreed definition or process for it (Karat 1997). However, the principles that Gould and Lewis (1985) present are generally accepted. The principles are:

1. Early focus on users and tasks.
2. Empirical measurement.
3. Iterative design.

The principles include the idea of user involvement: Gould and Lewis (1985) recommend bringing the design team into direct contact with potential users, as opposed to hearing or reading about them through human intermediaries. The second principle implies that, early in the development process, intended users should use simulations and prototypes to carry out real work, and their performance and reactions should be observed, recorded, and analysed.

Usability engineering tends to overlap with user-centred design and the two are often used interchangeably (e.g. Mayhew and Mantei 1994). Wixon and Wilson (1997) define usability engineering as a process for defining, measuring, and thereby improving the usability of products. Methodological approaches to usability engineering have been introduced by a number of authors such as Mantei and Teorey (1988), Nielsen (1993), and Mayhew (1999).

Participatory or co-operative design is an approach of Scandinavian origin (Floyd *et al.* 1989, Ehn 1993). Designers and workers have collaborated on understanding users and their tasks when planning and designing new business practices and interfaces. Users participate by analysing the organizational requirements and by planning appropriate social and technical structures to support both individual and organizational needs. Democratic participation and skill enhancement are important features of participatory design (Ehn 1993).

The early work in Scandinavia has been complemented in other countries (Muller *et al.* 1991, Clement and Van den Besselaar 1993, Schuler and Namioka 1993) and the approach has been applied in several research projects of the in-house or contract development type, and also in product development (Kyng 1994). Kuhn and Muller (1993) say that outside of Scandinavia, the field is more varied, with some theorists and practitioners pursuing a locally adapted form of democratic decision-making, and others emphasizing effective knowledge acquisition and product quality.

Ethnomethodological ethnography is a sociological approach that is also used to inform design of systems. It is most influential within the research communities of computer-supported co-operative work (CSCW), but also increasingly in HCI research (Dourish and Button 1998). It has become a shorthand or simplification to speak of ethnography instead of ethnomethodology in CSCW, while within sociology and anthropology themselves ethnography denotes rather little (Shapiro 1994).

Ethnography describes human activities and culture with a focus on the social aspects of human co-operation. Blomberg *et al.* (1993) characterize it with four principles:

Table 1. User involvement approaches.

	User-centred design	Participatory design	Ethnography	Contextual design
Emphasis	Usability	Democratic participation	Social aspects of work	Context of work
Typical methods	Task analysis, Prototyping, Usability evaluations	Workshops, Prototyping	Observation, Video-analysis	Contextual inquiry[1] Prototyping

[1]Contextual Inquiry is a field interviewing method which combines observing and interviewing (Beyer and Holtzblatt 1998).

1. It takes place in natural settings.
2. It is based on the principle of holism, that is, particular behaviours must be understood in the respective context.
3. It develops descriptive understanding in contrast to prescriptive.
4. It is grounded in a member's point-of-view. The main methods are observation and video-analysis.

The earliest attempts at linking ethnographic studies of work and design were with CSCW systems (e.g. Hughes *et al.* 1992). In a design context the aim of ethnography is to develop a thorough understanding of current work practices as a basis for the design of computer support (Blomberg *et al.* 1996, Simonsen and Kensing 1997). Lewis *et al.* (1996) describe the process of using ethnographic data for product development. Kensing *et al.*'s (1998) MUST-method combines the use of ethnographic techniques and intervention within the participatory design tradition in the context of in-house/custom development. Viller and Sommerville (1999a,b) have also developed an ethnographically informed method for requirements engineering and design process.

Contextual design is focused on studying people in their work (Holtzblatt and Beyer 1993, Beyer and Holtzblatt 1996, 1998, 1999). Users, usually one-at-a-time, are watched and talked with about their work while working in their own environment. The idea is to study the work processes and to describe and redesign them by changing role structures, supporting tasks, automating and eliminating unnecessary steps. The approach includes a general philosophy of visiting users. Beyer and Holtzblatt (1999) themselves describe contextual design as an approach to designing products.

Task analysis covers a wide range of methods in order to analyse a system function in terms of user goals and the sub-goals inherent in performing the task (Johnson 1989, Kirwan and Ainsworth 1993, Hackos and Redish 1998, Richardson *et al.* 1998, Annett and Stanton 2000). Much of the task analysis literature is devoted to the analysis of data, but task analysis also involves the users as informants (Diaper 1989, Jeffries 1997). In addition, task analysis may be used as a part of larger design methodologies. The identified goals, task sequences and hierarchies can be used in design in recognizing the familiar paths for users and the problems they have.

1.2. *Expected benefits of user involvement*

To truly understand user involvement we should have an understanding of the benefits such involvement brings about. The expected benefits of user involvement therefore serve as hypotheses to be tested.

According to Damodaran (1996) a variety of studies show that effective involvement in system design yields the following benefits:

1. Improved quality of the system arising from more accurate user requirements.
2. Avoidance of costly system features that the user did not want or cannot use.
3. Improved levels of acceptance of the system.
4. Greater understanding of the system by the user resulting in more effective use.
5. Increased participation in decision-making within the organization.

The list is somewhat participatory design focused, but it aptly illustrates the underlying assumptions regarding the benefits of user-centred design and usability engineering. For example, Gould *et al.* (1987) report their findings on the benefits of user centred design as: 'Extra effort in the early stages leads to much less effort later on and a good system at the end'. They also recommended that one must focus on users early on, in order to learn the type of system required. Also Nielsen (1993) states: 'Users often raise questions that the development team has not even dreamed of asking. This is especially true with respect of potential mismatches between the users' actual task and the developers' model of the task'.

The benefits 4 and 5 are mainly related to the features of participatory design. In participatory design, democracy is one of the main themes, the aim being that the workforce should be active participants in all decisions affecting their working lives.

2. Literature review

Research into user involvement is widely dispersed, ranging from descriptive case studies to cross-sectional surveys and covering many approaches, many types of products, development contexts and firms. The starting point for selection of the papers to review was the user involvement approaches suggested earlier. All relevant papers published in Interacting with Computers 1997–2000, Human–Computer Interaction 1995–2000, Interactions 1996–2000, and Communications of the ACM 1997–2000, among others, were considered for inclusion. In addition, books such as Field Methods Casebook for Software Design edited by Wixon and Ramey (1996), Participatory Design edited by Schuler and Namioka (1993), and Task Analysis for Human–Computer Interaction edited by Diaper (1989) were included. The CSCW area was excluded from this review. Plowman *et al.* (1995) provide a review of this area.

Three different research streams are reviewed. First, we review literature to find out what has been learnt about user involvement in field studies, which represent descriptive case studies including direct user involvement. The main goal of these case studies is not to evaluate user involvement but to give actual examples of field research (Wixon and Ramey 1996). Then we review qualitative research work, which focuses more directly on the helping and hindering factors of user involvement. Finally, the quantitative research on the effects of user involvement on system success is evaluated.

2.1. *Field studies*

The book 'Field Methods Casebook for Software Design' edited by Wixon and Ramey (1996) is full of positive experiences of user involvement. The frameworks of the cases were ethnography, participatory design, and contextual design. Many of the case descriptions present the benefits in the same vein as Ramey *et al.* (1996) do 'we feel confident that the method has proved useful'. Wixon *et al.* (1996) describe their findings and present a number of positive customer responses. Dray and Mrazek (1996) state that valuable insights were gained. However, no objective measurement of the benefits is presented and only a few authors describe the costs incurred on the cases.

Muller and Carr (1996) state that they spent less than 100 h in field studies and found major benefits to be in understanding, redirection of effort, downstream technology understanding, and improved mutual understanding and work relationships among all the stakeholders. Rowley (1996) estimates that two-and-a-half weeks of travel and data gathering was spent on the initial stage of their project. He mentions two main benefits found: (i) customers usually viewed the visits as a form of respect and appreciation; and (ii) the decisions of software developers were more likely to match the needs of the users. He also mentions that relatively little time was spent in change control meetings discussing design changes which originated from the study because the credibility of the source reduced the controversy that often contributes to the amount of time spent determining priorities. He also reported a number of field-study challenges: the amount of raw data collected during the study can be overwhelming; impacting the design can be difficult if field-oriented methods are not an accepted part of the development process; and gaining direct access to customers can be difficult.

Brown (1996) does not mention how much time they spent on field studies. She states that they received data that was invaluable in supporting decisions, but that the time needed for the actual studies, the communication, and management of large amounts of data remained their biggest problems. She also found that users were generally happy, although some users began to request that changes be made to their system. Bauersfeld and Halgren (1996) also found that they gathered useful data and experienced considerable success in turning data into design, but they suggested that a more efficient way to compare subjective data across users should be developed.

Juhl (1996) describes the experiences of using contextual inquiry in Microsoft product development. The research project was completed in 60 days and the project team felt that this cost was reasonable, given the depth and breadth of information obtained about customers' tasks, and the benefits being realized from data reuse. The design teams explained that contextual inquiry and follow-on users centred design activities provided them with a long-term vision for product development efforts and helped them in the understanding of the customers' needs. On the other hand, the projects revealed that contextual inquiry studies are too time-, labour-, and attention-intensive for them and it was difficult to generate clear deliverables for upper management.

Coble *et al.* (1996) spent approximately 1600 h in contextual inquiry sessions and data analysis. They feel the benefit gained was the ability to gather accurate and comprehensive information about their users' needs. One of their users even commented that the users were impressed with the comprehensiveness of the resulting requirements.

Blomberg *et al.* (1996) combined ethnography and participatory design in their law firm project. They found that ongoing relations between developers and strategically selected worksites can deepen developers' understanding of the problems that workers face, but that making work-oriented design an integral part of system development will require resources to be committed to alternative forms of design practice.

In summary, the field studies into user involvement were positive. The authors felt they gathered invaluable data from users, the data helped them in understanding of the customers' and users' needs and customer and user responses were positive. Conversely, costs and other hindering factors were mentioned such as:

- the overwhelming amount of raw data collected;
- the difficulty in impacting design;
- the difficulty gaining direct access to customers;
- the time spent on studies, communication and management of large amounts of data;
- users requesting changes to their system.

Karlsson (1996) also reported the positive aspects of field studies. She completed four empirical studies of four requirements gathering processes using different methods like interviewing and observing. The results of the empirical studies showed that different data collection methods contributed to the overall results, as well as to the requirements formulated. In general, a more complete picture was gained by using the field studies.

Rockwell (1999) reports extremely positive experiences of contextual design. He found that contextual techniques resulted in a better-targeted product, higher customer satisfaction, reduced development time, and better team synergy and focus for delivery. The costs of analysing the data were not reported.

Not everyone finds field studies as successful. Butler (1996) reported that 'If you have talked to colleagues who have tried these methods, you'll find that although this is important and informative work, it is also very hard to do. It's difficult to find users willing to let you watch them work, it can be a tough sell to get developers out of the office and into the field, and it's hard to make sense of the data that you collect'.

Butler (1996) reported the problems he encountered as follows:

- users were reluctant to let the researchers watch them work;
- finding users willing to let the researchers watch them work took much longer than finding users for typical usability sessions;
- users rarely did real work when the researchers came to visits. It was difficult to arrange their day so that they would have real work to do when observed.

Their solution was to conduct 'roundtables', where anybody from the team who wanted to, could 'sit around' in pleasant conference rooms and chat with a user who had brought in examples of the work they do everyday.

To conclude, the experiences gathered seem to confirm some of the expected benefits of user involvement. It was felt that more accurate user requirements were gathered and user needs were better understood. Positive customer and user responses were reported. But many challenges to improve field study techniques exist, e.g. how to spend less time in using them, how to analyse a large amount of data and how to compare subjective data across users.

Plowman *et al.*'s (1995) review of workplace studies and ethnographically oriented studies brought out similar results within the area of CSCW. The main outcome of these studies was in the different forms of insight, which were usually reconceptualized at a more abstract level. However, at this point, most of the research ceased and few publications reported further developments. Moreover, fieldworkers were found to have problems with communicating results to system developers and with effecting design work. The authors accordingly suggest that the majority of designers do not have the time, inclination or expertise to consider field study findings and that information may not always be of practical use to system developers.

2.2. *Qualitative research: helping and hindering user involvement*

Wilson *et al.* (1996, 1997) tried to directly assess the relationship between the costs and benefits of user involvement. The results are summarized in table 2. The first study of Wilson *et al.* (1996) was a cross-sectional survey of 25 practitioners. The intention of the survey was to receive an initial indication of the costs and benefits of user involvement. Indeed, 15 out of the 25 practitioners who responded reported some degree of user involvement in the design project in which they had been recently engaged. The respondents were asked to list the strengths and weaknesses of each design activity and the benefits and problems associated with the involvement of users.

Wilson *et al.* (1996, 1997) continued this work with a longitudinal study of one design project where the designers were interviewed. Wilson *et al.* (1996) identified the costs and benefits of user involvement, whereas Wilson *et al.* (1997) concentrated on the obstacles and facilitators of user involvement from both the user and designer points of view.

All in all, the data of Wilson *et al.* (1996, 1997) tends to be qualitative in nature and therefore the relative significance of the costs and benefits is impossible to estimate. The findings were similar to the other studies described earlier. Users provided information, they were generally satisfied and accepted the design, but also drawbacks and obstacles to the user involvement were apparent. Hirschheim (1989) had obtained similar results earlier.

Findings now being reported by Wilson *et al.* (1996, 1997) involved difficulties in communicating between users and developers. The authors concluded that ideally, all stakeholders should be motivated and users should be educated about the entire design process. The rationale for these different problems with user involvement seems to be that the user involvement in these design projects was more participative in nature and no special technique of user involvement was used.

Grudin (1991b) tries to understand the obstacles of user involvement in the product development context.

Table 2. The obstacles and benefits of user involvement.

	Design context	Obstacles	Benefits
Grudin (1991b): a survey and interviews of over 200 interface designer, conversations and experiences	Product development in large organizations	• Motivating the developers were challenging. • Identifying appropriate users was difficult. • Obtaining access to users and motivating the users. • Developers did not know how to benefit from user contact and how to obtain feedback from existing users. • Not enough time.	The benefits were out of the focus of the paper. User involvement is believed to be necessary in order to understand user requirements.
Wilson *et al*. (1996): a questionnaire of 25 practitioners	Not reported	In the preparation phase: • Users lacked information as to what the designers needed to know. • Users lacked information about what design process meant. In the design phase: • Little consensus across users, the problem was in finding compromises between groups. • Users introduced new concepts, and there were generally too great a volume of feedback. In the evaluation phase: Overall: • Users became more exacting. • There were often too many user groups.	In the preparation phase: • Users provided information and feedback. In the design phase: • Users identified interaction issues, which had to be addressed by users within the specific application domains, provided ideas and offered a practical view. In the evaluation phase: • Involvement from users, comments, feedback, suggestions, commitment, criticism, acceptance, improved usability, learning by designers and project leaders. • The feedback brought the user interface closer to task Overall: • Users were satisfied. • Users accepted the design.
Wilson *et al*. (1996): a longitudinal study of a one design project, interviews of designers	In-house	• Users had to be educated about design. • Users were unaware of implementation constraints. • Designers spent lots of time contacting users and arranging meetings.	• Users provided useful information and ideas. • Users helped define the scope of the project. • The system from the customers point of view, was improved. • Users were happy with the results. • Users learnt about their job and organization.
Wilson *et al*. (1997): a longitudinal study of a one design project, interviews of designers and users	In-house	• Limited time for the first phase of the design. • Users were very busy. • Some users lacked confidence or motivation and were reluctant to talk to the designers. • Some users did not understand the task model used. • Users were unaware of implementation constraints.	• Users were eager to participate, because they wanted to influence on the outcome. (The benefits were out of the focus of the paper.)

His conclusions rely on an earlier survey and interviews with over 200 interface designers from several product development companies; experiences in product development; and conversations with fellow developers. The benefits are not discussed, simply because Grudin (1991b) believed that user involvement is necessary in order to understand user requirements. He describes the obstacles in development environments preventing user involvement (table 2.). The problems are similar to those mentioned by Wilson *et al*. (1996, 1997) concerning the motivation of designers and users. In product development, identifying appropriate users was also found to be problematic, as the actual users of a product are not identifiable until the product is actually bought.

Grudin (1991b) found that certain aspects of the interface and user involvement are undervalued in decision making in these organizations and that interface quality is readily compromised. He suggests that more positive conditions of direct user involvement in product development can be achieved by altering the structure of organizations and product development processes. He recommends organizations to follow Gould's (1988) principle of putting all the usability aspects under a single management and the use of methods such as user involvement in iterative design with prototyping.

2.3. *Quantitative research: the effect of user involvement on system success*

Part of the research work has focused on the direct effects of user involvement on different aspects of system success. Mantei and Teorey (1988) introduced the topic of cost-benefit analysis of usability engineering by discussing the cost of incorporating a wide range of usability engineering activities into the development cycle. Bias and Mayhew (1994), Karat (1997) and Lund (1997) provide a framework for cost-benefit analysis and several excellent examples of cost-benefit analysis, demonstrating that usability activities bring value to corporations. The following are brief examples of the estimated benefits.

2.3.1. *Increased sales*: Based on 'buy decision' data from usability tests and surveys, it is estimated that the new usability-engineered system will have sales that are 25% higher in the first year compared with 'product development as usual' (Karat 1994).

2.3.2. *Increased user productivity*: In one case, the reduction in user time to complete the first three tasks from the initial to the final version was 4.67 min after three iterations of usability design and testing (Karat, 1997). The application had 22 876 end users, so the working time saved was 1781 h. The evaluated cost-benefit ratio of task analysis, development of a low-technology prototype, three iterations of usability testing, and redesign was evaluated to be 1:2. In another case, the reduction in time on task from first to final user interface was 9.6 min on average after a benchmark test, development of a high-technology prototype, three iterations of usability prototype testing, and redesign (Karat, 1997). The cost-benefit ratio of the usability work was evaluated to be 1:100.

2.3.3. *Decreased training costs*: Dray and Karat (1994) estimate that a well-designed system could decrease training costs by 35%. The project team conducted iterative usability evaluations for prototypes and moved their offices so that they were in constant contact with users and the context in which they performed their work.

2.3.4. *Decreased user support*: Microsoft announced that the number of support calls dropped dramatically as a result of usability testing and problem identification, leading to a revised design (Reed 1992). The average time per call fell to less than 10 min instead of the earlier 45 min. Similarly, the Ford Motor Company changed 90% of their accounting software for their small car dealerships as a result of usability testing and they were able to drop the help-line calls to zero (Kitsuse 1991). Earlier, it took the car dealers three help-line calls merely to get started.

As Bias and Mayhew (1994) conclude, after the worth of usability engineering is realized, it becomes a question of how much resource to expend and how to apply that resource. The cost-effectiveness of different types of usability evaluation methods has been evaluated in several research studies. Jeffries *et al*. (1991) compared four user interface evaluation techniques: heuristic evaluation, software guidelines, cognitive walkthroughs, and usability testing. They found that heuristic evaluation by several UI specialists revealed the most serious problems with the least amount of effort. However, it also identified a large number of low-priority problems and required several highly skilled UI professionals. Usability testing was the next most effective method; it was particularly reliable in discovering relatively serious and recurring problems.

On the other hand, Karat *et al*. (1992) compared individual and team usability walkthrough methods, including heuristic evaluation and usability testing. They found that across two systems, empirical testing identified the greatest number of problems; it identified a significant number of relative severe problems that were missed by the walkthrough methods. The total number of usability problem tokens revealed by empirical testing was approximately four times the total number of problems identified by team walkthroughs, and about five times the total number found by individual walkthroughs. Empirical testing required the same or less time to identify each problem compared to walkthroughs.

Furthermore, Desurvire (1994) describes a set of studies in which heuristic evaluations were compared to empirical testing. In one such study, human factors experts using heuristic evaluation, revealed only 29% of the most serious problems identified by empirical testing. One explanation for the differences of the results compared with Jeffries *et al.* (1991) is the different way of evaluating problem severity and validity. A method is required for discovering if predictions of usability problems were realized. Jeffries *et al.* (1991) used UI specialists to evaluate the problem severity, but Desurvire (1994) assumes that usability testing simulates to some extent the problems in reality.

In summary, usability inspection yields somewhat different results than empirical testing, the most difficult problems are usually revealed by testing with real users, and these methods can be seen as complementary (Karat *et al.* 1992, Desurvire 1994, Karat 1994, Nielsen 1994). However, as effective as usability inspection methods are, as Desurvire (1994) points out, primary to a system's success is whether it can facilitate a users' job, task, or life in some useful way, and the usability evaluation methods do not address these issues (see also Wixon *et al.* 1994). Kujala and Mäntylä (2000) offer an example of how even large-scale usability testing does not necessarily lead to the ideal, if users and context of use are misunderstood. Furthermore, Lund (1997) argues that cost-benefit analyses should rather emphasize an important contribution of usability engineering – matching design with need, identifying new product or business opportunities and thus supporting the revenue strategy of the company. The next step could be to evaluate the cost-effectiveness of the methods that take into consideration user needs and context of use.

User involvement is also a recurrent theme in management literature where the focus is on user participation. Ives and Olson (1984) already identified over 30 empirical studies where user involvement was a key variable. In general, the studies relate user involvement and system quality, system usage, user attitudes, and user information satisfaction.

However, the studies did not provide consistent evidence of the benefits. It was argued that serious theoretical, methodological, and measurement problems were associated with the past research (Ives and Olson 1984). For example, the operational definitions of user participation and user involvement may have been imprecise. The participation measures rarely reflect actual user influence on the physical development of the system and objective indicators of system success are rarely employed. Some later studies maintain that the results of user participation depend upon various contextual factors (Saleem 1996).

Saleem (1996) suggests that the functional expertise of users modifies the relationship between user participation and system acceptance. User influence on system development becomes vital for system acceptance when users are perceived to possess greater system-related functional expertise than other members of the design team do. This influence becomes less critical when users appear to possess less expertise than those influencing system design do. Similarly, Hunton and Beeler (1997) found that low self-efficacy perceptions might inhibit the user's desire to participate in development activities. Hawk and Dos Santos (1991) found in their field study that user participation was more closely related to user information satisfaction when the system was used for decision support and not for transaction-processing and when users were at higher levels in the organization.

The results of some recent studies have been summarized in table 3. The results show that the user participation has positive effects overall. Baroudi *et al.* (1986) report that the correlation between user involvement and system usage is 0.28 and between user satisfaction and user involvement 0.18, in their survey of 200 production managers. These correlations are statistically significant, but weak in effect. User involvement is explaining 8% of the variance in the system usage and 3% in user satisfaction. Barki and Hartwick (1991) also found a positive, although insignificant correlation between user participation and system usage ($r = 0.17$). In their study, a significant correlation between user participation and personal relevance of a system to its users was found ($r = 0.36$).

McKeen and Guimares (1997) found a positive and significant correlation (0.42) between user participation and user satisfaction in the systems development of 151 projects. Thus user participation was explaining 18% of the variance in user satisfaction. Data was collected from the project leader in charge of the development and from the primary end user(s) of each system. Dysfunctional user participation was never found in these 151 projects. User participation, even in low-need situations, was positively related to user satisfaction. Nevertheless, it was observed that users need to be far more involved in cases of high task and/or system complexity. If task and/or system complexity were low, only the core set of user participation behaviours improved user satisfaction and other behaviours like project definition were not linked with satisfaction.

Foster and Franz (1999) found there to be a strong significant correlation between users' self-perceptions of participation and system acceptance indicators of functional features ($r = 0.42$ and 0.32). Users' self perceptions of participation had a weak but statistical significant negative correlation with an acceptance indicator of generic system attributes ($r = -0.05$).

Table 3. A summary of the effects of user involvement on system success.

	Design context	Negative effects	Positive effects
Barki and Hartwick (1991): a survey of 105 users	In-house		• User participation had a positive, although nonsignificant correlation with system usage ($r = 0.17$). Participation correlated statistically significantly with personal relevance of a system to its users ($r = 0.36$).
Baroudi *et al*. (1986): a survey of 200 production managers	Varied information systems		• User involvement in the development of information systems enhanced statistically significantly system usage ($r = 0.28$) and the user's satisfaction ($r = 0.18$).
Foster and Franz (1999): a questionnaire of 87 users and 107 analysts	Varied information systems		• Users' self perceptions of participation had a moderate significant correlation to system acceptance ($r = 0.42$ and 0.32 for acceptance indicators of functional features). • Analysts' perceptions of user participation correlated strongly and significantly with all indicators of acceptance ($r = 0.81$, 0.75, 0.55 and 0.50).
Heinbokel *et al*. (1996): a longitudinal field study of 29 projects	External and in-house	User participation in software development was associated with project difficulties: • lower overall success ($r = -0.47$); • fewer innovations ($r = -0.40$); • lower degree of flexibility ($r = -0.44$); • lower team effectiveness ($r = -0.45$).	
Keil and Carmel (1995): an interview of development managers of 17 companies	Product development and in-house		• More successful projects employed more direct links to users and customers.
McKeen and Guimares (1997): interviews and questionnaires to users and developers from 151 projects	In-house business applications		• Positive and significant relationship between user participation and user satisfaction was found ($r = 0.42$). User participation was never dysfunctional in these 151 projects.

Thus, users valued the functional features of a system that are directly useful to them in performing their tasks, rather than generic system attributes. Analysts' perceptions of user participation correlated strongly and significantly with all indicators of acceptance ($r = 0.81$, 0.75, 0.55 and 0.50).

Keil and Carmel (1995) showed that direct links to users and customers related to projects that were evaluated as successful by managers. However, the term 'link' was used broadly. It included many kinds of activities from observational study to support line. Direct links were those in which the customer and developer deal directly with one another and not through intermediaries or customer surrogates.

Similarly, Chatzoglou and Macaulay (1996) found that in projects where users and documentation are used as primary sources of information, the number of iterations needed for the completion of the requirements capture process is one or two. In contrast, in projects where users are a secondary rather than primary information source, the number of iterations increases and three or more iterations are then needed. In addition, Blackburn *et al.* (2000) found that more time and effort invested in the early stages of a software project yields faster cycle times and improved productivity.

The only study demonstrating purely negative effects of user involvement on system success was the longitudinal field study by Heinbokel *et al.* (1996), who assessed quality factors of the development process and the product in two measurement periods during the development process, using interviews and questionnaires. The participants were 200 team leaders and users' representatives from 29 application software development projects in Germany and German speaking Switzerland. The participants were asked to evaluate among other things the amount of user participation, the overall success of the project, the amount of innovations made during development, flexibility of the project (i.e. reaction of the project to unpredicted events), and fulfilment of time and budget requirements. Users' responses to the final products were not studied.

In this study, in the projects where the level of user participation was high, the system analysts and programmers, team leaders, and user representatives evaluated the overall success of the project to be lower. Similarly, in their opinion, these projects showed fewer innovations and a lower degree of flexibility. The results also suggest that high user participation and even user orientation correlates negatively with the evaluated team effectiveness and quality of team interaction. Heinbokel *et al.* (1996) explain that user participation disturbs the process of software development. The participation projects had to deal with several problems related to developer-user relations that were not present in projects without user participation. For example, users proposed new ideas and demanded changes in a later stage of development.

The results of Heinbokel *et al.* (1996) appear at first to be contradictory. However, the work was the first survey to target team leaders, developers and the relationship of project work to user participation. User participation was defined on the basis of the number of user representatives in a project. So the user involvement was participative in nature, and the participation was presumably informal. The overall success of the project was measured by a single subjective scale. User participation was negatively ($r = -0.31$) but not statistically significantly correlated with the measure of on time/in budget in any significant manner. However, those projects that were thought to be inefficient were, in fact, less often completed within the second measurement time than were projects that were thought to be efficient ($r = -0.40$, $n = 26$, $p < 0.05$). One interpretation of the results is that the projects encountered communication problems with user representatives and this in turn had a negative effect on the perceptions of project success and the fulfilment of time and budget requirements.

3. Summary and Conclusions

In this study, we have discussed the nature of user involvement – its benefits and challenges. In particular, the purpose has been to understand early user involvement and its value in requirements gathering even before a prototype of the system exists.

The three streams of research reviewed here seem to have similar results. User involvement is clearly useful and it has positive effects on both system success and user satisfaction. The streams of research reveal some evidence relating to the Damodaran's (1996) expected benefits of user involvement. Table 4 shows the expected benefits, which were supported, by the different research streams.

The results of field studies and qualitative research suggest that developers experience that they get more accurate user requirements by involving users. The benefits of prototyping and iterative usability evaluation are clearly demonstrated, but it is more difficult to prove empirically the cost-effectiveness of user involvement in

Table 4. Evidence offered by the three streams of research supporting the expected benefits of user involvement.

	Research streams		
Expected benefits	Field studies	Qualitative research	Quantitative research
More accurate user requirements	X	X	X
Avoiding costly system features that the user did not want or cannot use	X	X	X
Improved levels of acceptance of the system	X	X	X
Greater understanding of the system by the user			
Increased participation in decision-making in the organization		X	

gathering user needs before a prototype exists. Only the work of Chatzoglou and Macaulay (1996) demonstrates it, albeit indirectly, by showing that users as the main source of information decreased the number of iterations needed.

The benefit of avoiding costly system features is not directly shown, but it can be evaluated that usability engineering can reduce the time and cost of development efforts through early identification and resolution of usability problems (Karat 1997). The improved levels of acceptance of the system were found in qualitative and quantitative research; the relationship between user involvement and user satisfaction is particularly strongly supported by all three research streams. The positive effects of user involvement in system usage also have some support (Baroudi *et al.* 1986, Barki and Hartwick 1991).

The benefits of a greater understanding of the system or increased participation in decision-making were not the focus of these studies. Only Wilson *et al.* (1997) mentioned that users were eager to participate, because they wanted to influence on the outcome, and Cherry and Macredie (1999) argued that the improvement of work organization and industrial democracy were the key benefits of participatory design in their case study. Clement and Van den Besselaar (1993) found in their review of 10 participatory design reports that the relationship between user participation in systems design and the pursuit of workplace democracy is a complex one. The authors of the reports generally note that the local participants increased their competence on new technology and became more willing to take the initiatives with it. Nevertheless, Clement and Van den Besselaar (1993) found that participatory design is characterized by isolated projects with little indication that it leads to self-sustaining processes within work settings.

The effects of user involvement seem to be positive overall, but complicated. Figure 1 summarizes the effects of early user involvement. The early user involvement may be a positive value for users and customers as such, as described in figure 1. However, the main effects come through intermediate factors such as better user requirements.

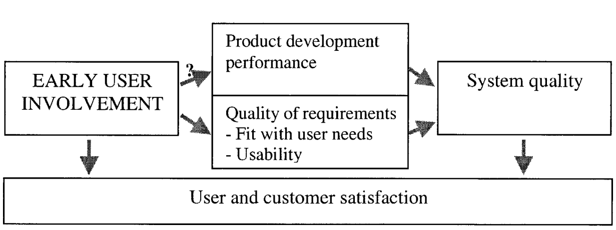

Figure 1. The effects of early user involvement.

Early user involvement additionally affects the performance of the product development team but in somewhat contradictory ways. The results of Chatzoglou and Macaulay (1996), Keil and Carmel (1995), and Poltrock and Grudin (1994) suggest that user involvement can have positive effects on project work and the number of iterations required. Poltrock and Grudin (1994) found that designers viewed marketing as ineffective in obtaining the information needed in order to define their product requirements and they were frequently frustrated by the difficulty of deciding what to do without the relevant information from users. Good's (1992) case study also reveals some initial evidence to the effect that an understanding of the user's world can lead to more innovations.

However, implementation of user involvement in projects can be demanding. In particular, Heinbokel *et al.* (1996) and Wilson *et al.* (1996) show that the participative approach to user involvement may have negative effects on project work. Normally, it is reported that usability engineering reduces the development time (Karat 1994, Mayhew and Mantei 1994). For example, the value of correcting usability problems early is estimated by making the assumption that changes made early cost only one-quarter of what the same changes made late would cost (Mantei and Teorey 1988, Mayhew and Mantei 1994). However, Heinbokel *et al.* (1996) and Wilson *et al.* (1996) report that when users are participating in the design project, problems arise when users demand changes in a late stage of development or designers must resolve conflicts between user groups. As Hawk and Dos Santos (1991) point out, user involvement in the form of participation is a costly process that requires time and effort on the part of users as well as developers. Developers and users tend to have difficulties in communication and users have to be educated in what design process actually means (Wilson *et al.* 1996). The costs can be said to be reasonable given that user involvement has positive effects on project success and user acceptance, but there are challenges to improve user involvement in practice.

My overall interpretation is that involving users is not an easy task for designers. Early involvement of users appears to be promising, on the condition that user involvement methods are developed further and the roles of users and designers are carefully considered. Designers should take an active role in user involvement. Users are experts in their own field, but they do not need to be experts on design. Field studies are a particularly promising approach for understanding users' implicit and non-verbal needs. Users are not just asked about their needs, but the analysts try to understand their behaviour and the future context of use. Users may not be able to communicate their precise requirements, but they are able to explain their goals and how they approach their tasks. Using this kind of information a designer can work out on behalf of the users the solution they need. Contextual inquiry and ethnographic methods seem promising, but challenges exist in the use and analysis of the huge amount of raw data collected.

However, we could ask if it is designers task to gather user needs or should projects use some kind of expert to gather information from users. At least, Keil and Carmel (1995) argue that indirect links between developers and customers (including users) are less desirable to use because of information filtering and distortion. It is clear that developers may have difficulties in understanding users and empathizing with them if they have never seen them.

3.1. *Agenda for future research*

As remarked earlier, our understanding of how user involvement affects product development is incomplete. These shortcomings present opportunities for future research. For example, even if usability is the principal goal of user involvement in HCI, too little effort has been dedicated to evaluating how and how much the early involvement of users (e.g. field studies) contributes to the usability of the final product. Thus, it is hard to convince companies of the importance of field studies (see Kaasgaard 2000). This has led up to a situation whereby many companies focus their usability efforts on usability testing. Methods and handbooks do exist for usability testing, but in this manner usability is treated primarily as error detection and elimination (Lund 1997).

In addition, an opportunity exists in examining the effects of early user involvement in system development. Problems may arise, for example, when users get new ideas and demanded changes during a late stage of development. However, developers may also spend a considerable time in arguing with each other. As Nielsen (1993) describes it: ‘It is amazing how much time is wasted on certain development projects by arguing over what users might be like or what they may want to do. Instead of discussing such issues in a vacuum, it is much better (and actually less time-consuming) to get hard facts from the users themselves’. Thus, user involvement can also have positive effects on development, if it provides facts on which decisions may be based and the user involvement is implemented in a designer-controlled way. This also helps minimize design errors and the need to make expensive changes.

Perhaps simple user participation is not enough; developers need techniques on how to understand users and their needs. These techniques exist, but all of the varied approaches attract both supporters and critics and few objective comparisons of methods or approaches are available. Maiden and Rugg (1996) have tried to evaluate the requirements – acquisition methods, including ethnography. They evaluated that requirements engineers need considerable training in the use of ethnographic methods and that the methods may take a considerable time to master. Even the supporters admit these problems and they identify the principle problem to be the presentation of the results of ethnography in a form that is readily usable by designers (Hughes *et al.* 1995).

We also know that the participatory role of users may lead to problems in development (Heinbokel *et al.* 1996) and that contextual inquiry may lead to a vast amount of raw data. The problem these approaches have in common seems to be that there needs to be a closer connection to system development work. As Millen (2000) points out, the ever-increasing pace of new product development requires more time efficient methods.

Fortunately, the approaches develop constantly. Hughes *et al.* (1995), for example, have developed more focused ‘quick and dirty’ ethnography, in which fieldworkers undertook short focused studies to gain a rapid understanding of the work setting or to check the sanity of an already formulated system proposal. Millen (2000) also introduced rapid ethnography, and Viller and Sommerville (1999a,b) have developed an ethnographically informed method for requirements engineering and design process. Wood (1997) has developed more efficient ethnographic interviewing techniques. In their book Hackos and Redish (1998) introduce practical guide for user and task analysis combining different approaches and techniques to task analysis. Lafrenière (1996) has developed a collaborative low-cost approach to task analysis. Currently, a research challenge exists to evaluate these new approaches and their effectiveness in real developmental contexts.

The approaches are beginning to resemble one another. In the end, the question may not be what approach and methods to select, but what we can learn from these methods and approaches, and what methods we should use may depend on the situation. Participatory design is the bottom rung for the user involvement philosophy and users’ rights: it introduced the idea of bringing end users into direct contact with designers. Field methods, such as contextual design and ethnography, provide methods for communicating with users and understanding users’ implicit needs. Contextual design proposes, for example, the good principles of visits to users and user – developer relations. Ethnography offers information on how to study social aspects of work. Task analysis demonstrates the importance of goals, tasks, and task sequences.

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