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Kaija Collin

Experience and Shared Practice

Design Engineers' Learning at Work

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UNIVERSITY OF JYVÄSKYLÄ

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ABSTRACT

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The study investigates design engineers' and product developers' learning through their work. The aim was to approach designers' work practice and their learning in the course of it as perceived by the designers themselves. The aim was also to examine their learning through the various individual and social processes which take place in the workplace. The study thus addressed three major questions: 1) What conceptions do engineers have of learning at work? 2) What role do previous work experiences have in on-the-job learning in the domain of design work? and 3) How do engineers learn through shared practices of design and development work? The report is based on five articles published in 2002–2005.

The ethnographic approach with its use of combined and qualitative data gathering and analytical methods was selected to answer the above questions. Observations in two Finnish high-tech companies and interviews with 18 designers were conducted within an ethnographic framework. The observations and interviews were analysed with help of combined methods of analysis, such as phenomenographic, narrative and ethnographic analysis.

The findings suggest that in redefining designers' work and learning, four central themes are important: 1) design practice is learning in itself; 2) there is a close relationship between formal and practical knowledge in designers' learning at work; 3) previous work experience plays an essential role in learning; and 4) design practices and learning should be seen as shared, situated and contextualized. It was concluded, on the more general level, that the learning which takes place at work cannot be approached with the help of vocabulary borrowed from formal education. Neither can this phenomenon be described solely as informal. Moreover, individual and social practice and learning in the workplace should be seen as interdependent and intertwined.

Various further ideas for researching designers' learning in their practice and how the formal education of designers could be developed in connection with these ideas are offered. In addition, more general suggestions concerning the guidance of workplace learning are given, and the challenges of guiding and assessing workplace learning in the vocational education context are examined. There is a clear need for more effective integration between education and working life.

Keywords: design work, designer, learning at work, experience, shared practice

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PREFACE

Commencing post-graduate studies alongside the various responsibilities of working life is always not only a question of will and personal interest. Frequently, it is also a question of opportunity. After I had been working for several years as a teacher in Jyväskylä Open University this opportunity was opened up to me by Professor Päivi Tynjälä, who called me one day, about six years ago, to ask if I was interested in working in a research project. A word of thanks here is also due to Professor Erkki Olkinuora who, as coordinator of the research project *Growing Demands and Skills and Knowledge. Learning and Development of Expertise in the Information Society,* invited me to join this research group. That initial call was the prologue to a process which is now near its completion, and it is time to thank all the people who have made it possible.

Taking a leap from the world of education and teaching to the world of scholarly research was a challenging step for me and without the warm guidance of my "supervisory team", consisting of Professors Tapio Vaherva, Päivi Tynjälä and Emeritus Professor Juhani Kirjonen, the start of this dissertation project would have proved much more difficult. I am especially grateful for the team's expertise and collaborative attitude which brought me face to face with research work and with the world of adult and workplace learning. I was fortunate to be able to be included in this professional group of people who were always there when ever I needed advice. I felt that I was a privileged member of a team, not just another post-graduate student. I also want to thank Professor Anneli Eteläpelto who supported me, especially during the final steps of the process. She has always carefully read my manuscripts and given me insights in how to further develop my thinking.

I also want to express my gratitude to the two reviewers, Professor Annikki Järvinen and Associate Professor Stephen Billett, who have carefully read this report. Their warm and encouraging and yet critical approach has shown me what needed to be further elaborated in this report as well as in future research. I also want to thank Stephen Billett for hosting me during my visit to the Centre for Learning Research, Griffith University, Australia in the autumn 2004. This visit gave me an opportunity to concentrate on finishing the summary of the dissertation and enabled the prompt completion of the writing process.

Even though post graduate studies are usually seen as a lonely and individual effort, for me it has also been a collaborative process. Firstly, I want to thank the Institute for Educational Research for providing me with favourable circumstances in which to do this work and for supporting me in many ways from the beginning to end. A novice researcher also needs the guidance of more experienced practitioners. The research team on Learning, Education and Changing Working Life has also given me a lot of support and has had an important role in surrounding me with multifaceted professional know-how and competence. I also would like to express my gratitude to

Marjatta Saarivaara who has helped me in making methodological choices. I have also spent many enjoyable and inspiring moments with my colleague Ulla Maija Vallela in composing joint articles and other work. I owe a big vote of thanks to my fellow-workers Maarit Arvaja and Raija Hämäläinen, among many others, for many discussions in which experiences and good practices of work and study have been shared. My special thanks at the Institute for Educational Research go to Minna Jokinen and Virpi Kupari for their practical help in finishing the report. In addition, I am especially grateful to Michael Freeman, at the Department of languages, for taking the pains to polish my, time to time, hopeless English. Without his help my work would not have been so reader-friendly.

Naturally I want to thank the design engineers who have participated in this research by giving me their precious working time and tolerating me wandering around their places of work. Without their engagement and interest the whole process would have been wasted. For financial support I wish to thank the University of Jyväskylä, the Institute for Educational Research, the Open University, the Academy of Finland and the Finnish Work Environment Fund.

Outside of the academic team there are many other people who have supported me in one way or another. With colleagues at the Open University I have been able to discuss pedagogical issues. The frequent meetings of "the Portugal recollection group" consisting of Jani Ursin and Tuija-Leena Saikkonen have delighted me a lot. A morning coffee group at the Institute for Learning Research has offered many agreeable moments during which many current issues have been thoroughly dissected. Numerous friends united by their fondness for dogs have also helped me to think other things than work.

Above all, I want to thank my dear friends Tuija Hytönen and Sari Salojärvi for their academic as well as personal support as bosom friends. I am especially grateful to Tuija for your scholarly expertise in alerting me for the pitfalls of doing an academic dissertation and for your warm and sisterly closeness in all our shared activities. I am grateful to my parents Tuula and Simo Collin who have always backed me up in whatever new challenges have faced me in my life. Finally, I want to express my sincere gratitude to my beloved life-companion Tomi Lempinen for all the patience and companionship during this six years venture, not to forget our dear dog Nelli. You have shown me what the most important things in life are, after all.

Muurame 30.1.2005

Kaija Collin

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LIST OF TABLES

LIST OF THE ORIGINAL PUBLICATIONS

The thesis is based on the following articles, which are referred to in the text by their Roman numerals.

I Collin, K. 2002. Development engineers' conceptions of learning at work. Studies in Continuing Education 24 (2), 133–152.

II Collin, K. 2004. The role of experience in work and learning among design engineers. International Journal of Training and Development 8 (2), 111–127.

III Collin, K. 2005. Development engineers' work and learning as shared practice. International Journal of Lifelong Education 24 (3).

IV Collin, K. & Valleala, U. M. Interaction among employees – How does learning take place in the social communities of the workplace and how might such learning be supervised? Submitted in Journal of Education and Work 2005

V Collin, K. & Tynjälä, P. 2003. Integrating theory and practice? Employees' and students' experiences of learning and work. Journal of Workplace Learning 15 (7/8), 338–344.

Copies of the articles are appended to the report. In article IV and V the data which concerns designers' experiences is gathered and analysed by the author while the data concerning students and youth workers experiences is analysed by the second authors. In both articles this data has also been compared by all the authors. For more detailed description see the articles IV and V in question.

1 INTRODUCTION

The driving force of this research project derives from the desire to understand more deeply the challenging and multi-faceted phenomenon of learning in the workplace. Special interest is focussed on the processes of learning through work, and how it takes place in the course of work practices. Also the question of what it is learned at work, was asked simultaneously with the questions how. Existing efforts to answer to these questions were, however, rather few on the threshold of the new millennium when this research process began. Even now, some five years later, it can be argued that the phenomenon still lacks of a rigorous conceptual vocabulary despite the numerous research projects that have been conducted in this field. However, these studies have contributed to our understanding about learning through work in various organisational contexts and settings in their own right (see e.g. Järvinen, Koivisto & Poikela 2000).

The reasons for the growing interest in workplace learning over the last decade are diverse, and depend on the standpoint of the viewer. The concept of the knowledge society and learning society (see e.g. Heiskanen 1999; 2004), which is increasingly referred to, challenges workers and organisations to structure work in new ways. It also challenges workers to prepare for learning which may be life-long. In general, however, the renewed interest in workplace learning is wholly practical. From the point of view of enterprises and employers, for instance, employees' learning through work contributes to the development of the vocational and professional knowledge needed for work. An equally important reason usually associated with companies and organisations is that learning is directly relevant to their specific needs which, it is hoped, will lead to better productivity and increased competitivenes. At government level goals are often focussed on making the content of vocational education programs relevant to industry and directly applicable within enterprises, whereas teachers of vocational institutions attempt to assist their students to transfer classroom experiences to other, non-formal situations (Billett 2001a). For the individual worker, constant learning may be the route to

personal fulfilment and joy, progress in one's career or a way to strengthen the sense of self and identity (Lavikka 2004).

A personal motivation for embarking on this research was the interest which awakened when I worked within various vocational continuing education projects in the late 1990s. I was much taken by how convinced those engaged in vocational education were about the power of learning in the workplace in helping their students to qualify for working life as competent vocationals and professionals. Also, personal experiences of work communities have taught me that every working day brings many things to be learned, and these things are not necessarily related solely to the competencies needed, but to many other things and situations. Owing to the undefined and incomplete nature of the workplace learning, it was intriguing to think that researching this phenomenon might add to knowledge in this field. A further strong motivation was the significance of workplace learning both to people engaged in working life as well to those involved in developing vocational and continuing education in various sectors.

When this research began, Finland was in the middle of a period of economic expansion, which was also manifested in the ICT-sector in discourses of progress benign development in organisations, and of personal career advancement. Companies in the ICT sector had plenty of work. As a consequence of this, organisations were also able to invest increasingly the human resource development and organisational learning. It was also assumed that the general atmosphere for a study of workplace learning would be positive. Consequently, the occupation or profession so important in the rise and the maintenance of the knowledge society and Finnish success in the global markets, IT and product design was selected for study.

Since, until recently, the picture given of designers' work and expertise has been rather oversimplified and unproblematic, this study aimed to deepen the view of designers' work and learning as practical and social rather than of linear problem-solving alone. Also, the area of workplace learning, approached more broadly, was rather complex and muddled at the outset of this research process. However, there was an urgent need to investigate learning processes and the phenomenon of learning through the workers', and especially designers', own experiences and conceptions. In addition, interest was focused on the many social and individual learning processes which take place in the workplace. More importantly, purpose was to study these individual and social learning processes as intertwined, since this has been a less investigated approach at that time.

Thus the aim of the research was quite a practical one; viz. to describe and understand, how and what workers, and especially designers, learn at work. This understanding was to be built through the meanings given to work practices and learning through them by designers. Given that research in this field had been conducted unconstrained by any particular theoretical background or predefined family of concepts in the domain of learning in general, an ethnographic approach was selected as the research methodology.

Another reason for this was that the theories current at the time seemed to present rather an abstract picture of the phenomenon of workplace learning. Workplace learning, and designers' learning especially, thus needed to be investigated in authentic settings. It was also believed that learning would appear more clearly in real-life contexts.

In the first phase of the research, the purpose was to map designers' own conceptions of learning at work. After this, more specific questions were asked which were analysed using various methods within the ethnographic frame. The final research questions were not formulated at the beginning of the research process either. Instead, they emerged during the process along with the methods of analysis suited to their specific purposes. In this report, conceptual redefinitions and conclusions based on the findings of the study are thus presented at the end of it. Although a broad range of occupations and professions might seem to be a good choice in seeking to gain as comprehensive a picture as possible of the phenomenon at hand, only one occupational group, i.e. designers, was finally selected to furnish the subjects of the study. This is because it was assumed that by investigating one vocation or profession it is possible to take the contextual issues and other factors related to work tasks and aims better into account.

The results of the study have been reported in separate articles published between 2002 and 2005. This report is based on the five articles which are appended to it. The articles are referred to in the text by their Roman numerals, I–V. The report was drafted during the year 2004, and it reflects on the theoretical ideas, methodological choices and conclusions of the study. Since the summarising report is written at the end of the research process, it has also been possible to reflect on that process in the light of the accompanying debate on the issue of workplace learning.

The purpose of chapter 2 is to discuss and evaluate different conceptions of the phenomenon of workplace learning or learning through work. The aim is to describe, elaborate and evaluate existing approaches. This chapter also identifies a few problematic aspects connected to studies of the phenomenon of learning at work and serves to map those features of the workplace learning phenomenon which have not yet been fully addressed in the literature. In chapter 3 the work of product designers and development engineers is conceptualised on the basis on the recent literature and studies in the area. The major characteristics of design work are presented. In chapter 4, the purpose of the research and the research task are presented. Also included are a description of the study design and a short description of the articles included in the report. In chapter 5 the methodological choices made in the course of the research process are described and evaluated. This chapter includes a profounder reflection on the methodological choices than was possible in the articles themselves. Chapter 6 summarises the main findings obtained from the different phases of the research process and suggests a redefinition of designers' learning at work. The results can also be found in more detailed in the appended articles I–V. Chapter 7 draws together the findings of the study. It

also discusses the phenomenon of workplace learning from a more general perspective than that of a single professional domain. The chapter also continues the critical discussion of the methodological choices and, makes suggestions for further research as well as practical recommendations in the light of the findings.

2 CONCEPTIONS OF WORKPLACE LEARNING: APPRAISALS AND PROSPECTS FOR DEVELOPMENT

The purpose of this chapter is, first, to discuss and evaluate different conceptions of the phenomenon of workplace learning or learning through work. The aim is to describe, elaborate and present a critique of existing approaches which see learning through work as both an individual and social activity, since these are the enduring features of current conceptions of learning through work. The discussion also necessarily identifies a few problematic aspects connected to studies of the phenomenon of learning through work and seeks to map those features of the workplace learning phenomenon which have not yet been fully addressed in the literature. They are both conceptual and methodological in their nature.

In recent years the fundamental importance of the workplace as a site for learning has been reasserted. Learning at work is fast becoming a primary focus for scholars and practitioners in the area of adult education as well as governments, trade unions and enterprises. The reason for the re-emergence of this interest is largely pragmatic. Governments often lay claim to the goal of making the content of vocational education programs relevant to industry and directly applicable within enterprises. Enterprise interest in workplace learning, on the other hand, is usually associated with enhancing employees' access to skill development that is directly relevant to the enterprise's specific needs (Billett 2001a, 2–5). Significant numbers of private organizations and public agencies are seeking to improve their performance and competitiveness by adopting more flexible organisational structures and by introducing new ways of working based on information technology and communication. Knowledge-sharing with colleagues and the development of expertise has become one of the vital means in this process (see e.g. Boreham 2002; Chi, Glaser & Farr 1988; Eteläpelto 2000; Tynjälä, Nuutinen, Eteläpelto, Kirjonen & Remes 1997). The development of expertise may thus be seen as another important aim of learning at work (see e.g. Eteläpelto & Light 1999).

Thus different and conflicting purposes, as exemplified by the points of views of the different fields alluded above, may inform the goals of the workplace as a learning environment. This is reflected within the dominant discourses of learning at work, which contain a variety of perspectives, from seeing it as part of the larger culture and context of the workplace, even society itself, to seeing it as an important part of an individual employee's personal development in terms of skills and competence (see Fenfick 2001a; Garrick 1999). So, whereas the provision of a supportive learning environment is often seen as being critical to the success of learning through work, the purpose and form of that support needs to be considered in terms of the kinds of goals that are or are likely to be the focus of either individual or social activity in the workplace.

Beyond these concerns about purposes, a number of larger-scale studies, conducted through interviews and surveys, have sought to address issues about the processes and outcomes of learning through work. These studies address questions associated with what is being learned at work, how learning takes place at work and what kinds of factors affect the amount and direction of learning in the workplace (Eraut, Alderton, Cole & Senker 1998b; Gerber, Lankshear, Larsson & Svensson 1995; Gerber 1998). In some of these studies, learning at work has been approached, for instance, from the perspectives of goals associated with organisational learning and outcomes of participating in the organisational culture (Argyris & Schön 1996; Brown & Duguid 1991), developmental work research (Engeström, Engeström & Kärkkäinen 1995; Engeström 2001), reflective professional practices associated with personal enrichment (Marsick 1996), and learning as participation in communities of practice associated with the development and continuity of collectivity in workplaces (Lave & Wenger 1991; Wenger 1998). It is also widely acknowledged that practising a profession in a competent way not only requires an appropriate initial education but also involves learning throughout one's career (Eraut et. al. 1998b; Marsick & Watkins 1990).

Yet, despite the increasing number of studies conducted recently in the area of workplace learning, these practices, properties and potentials are not fully understood. There is a strong need for research on the nature of learning in the workplace from individuals' perspectives on how learning occurs, the various ways in which learning can be organised and controlled through social factors in the workplace, and, consequently, how learning in the workplace as a learning environment can more effectively be made to meet the needs of and benefit more people (Boud, Freeland, Hawke & McDonald 1998; Lähteenmäki, Mattila & Toivonen 1999). Of central importance here is a need to examine learning at work according to how it is seen by the actors themselves (see e.g. Garrick 1999, 1998). According to the studies cited above it is now time to focus on working practices themselves as sites of learning, as places where workers bring their particular perspectives to both practice and learning.

A problem in the discussion concerning the study of learning at work is that it is a very complex phenomenon, which still lacks systematic, sensibly

conceptualised and comprehensive theorisation. It suffers from three kinds of problems: 1) the enormous diversity of work in various parallel but non-overlapping fields of study and practice; 2) terminological proliferation; and 3) variation in the meaning of the same term depending on the ideological and organisational perspective of the writer or the speaker (Candy & Matthews 1998). Also, until recently, learning in the workplace has been studied relatively little compared to learning in educational settings. One reason for this may be that this area of research is still in its infancy. However, a more worrying concern is that assumptions from practices associated with educational institutions are being applied uncritically to workplaces as learning environments (Billett 2003b). Consequently, many studies in the area are largely based on approaches, methods and concepts borrowed from the formal education system (see e.g. Hager 2004a). A related conceptual issue, which follows from the former, is that the context-boundedness, the aims of work and how it is organized, have not been taken into account when studying the phenomenon. For instance, ways of learning at work have previously been investigated in larger-scale questionnaires only, with the consequence that larger picture of the contexts of learning as well as a deeper understanding of the phenomenon continues to be lacking (see e.g. Hodkinson, Hodkinson, Evans, Kersh, Fuller, Unwin & Senker 2004).

Consequently, arising from the problems described above, the ontological and epistemological premises of research in the area of workplace learning are still rather undeveloped or, at least, not clearly explicated in the literature. Instead, the starting point in many studies is practical, such as, for example, finding ways of developing learning through work. This is one reason why coherent theories and models of workplace learning continue to be few.

However, despite the eclectic and pluralistic nature of the research that has been done in the field and the deficiency of appropriate conceptual and methodological tools, it is possible to discern a certain measure of agreement about what characterizes this phenomenon. It is questionable, however, whether these characteristics can be told apart, because in the practice and individual experience of doing an actual job they are inseparable elements of learning. Instead, it may be wiser to perceive these characteristics as conceptual tools with which to understand the phenomenon of workplace learning better and also to see this characterization as a constellation of overlapping features which, in practice, are all important parts of the phenomenon as a whole. That is, to identify both their collective and individual contributions in understanding learning throughout working life. Since the field of workplace learning is large and multifaceted and can be approached from many different directions, it should be borne in mind that the next description of general characteristics of workplace learning is only partial. Many other relevant approaches could equally have been taken and other characteristics chosen. The choices made here are, however, the most relevant ones from the point of view of the particular aims of this research.

In the following sections, workplaces as learning environments are discussed under the four motifs of (1) situated learning, (2) participation, (3) practice and (4) collectivity. The general characteristics of workplace learning have been constructed by the author herself on the basis of the recent literature and studies in the area. The four characteristics are:

1) learning in the workplace is informal, incidental and practice-bound (i.e. situated learning)
2) experiences function as a foundation for work and learning (i.e. participation and engagement in work)
3) tasks and working contexts determine learning at work (i.e. practice and learning)
4) learning in the workplace is described as social and shared (i.e. collectivity and learning)

The epistemological points of departure of these characteristics thus vary from seeing knowledge as the individual's conception or experience to seeing it as a social construction built in group, team and organisational contexts.

2.1 Learning in the workplace as informal, incidental and practice-bound

The first approach to learning at work sees learning as situated, informal and incidental. In fact, it has been evident for some time that most of the learning that takes place in the workplace is informal (see Benson 1997; Watkins & Marsick 1992). Learning is seen as a natural aspect of everyday work and work itself is seen as a rich source of learning (McGill & Slocum 1994; Darmon, Hadjivassilou, Sommerlad, Stern, Turtsin & Danau 1998). Consequently, in this approach, learning is understood as ubiquitous ongoing activity, though often unrecognised as such (see Lave 1993). It takes place informally or incidentally in relation to everyday problem-solving as well (Argyris & Schön 1996). What and how one learns is also determined by circumstances, other people, innovations, discoveries and experimentation. Learning can thus be seen as a side effect of a person's work-related activities (Marsick & Watkins 1990). The recent studies also suggest that the purpose and direction of learning at work are largely derived from the goals of the work itself, arising naturally out of the demands and challenges of the job and out of social interactions in the workplace with colleagues and clients (Boud & Miller 1996.) Studies around the world, for instance in the US (see Darrah 1995) and in Japan (see Koike & Inoki 1990), have shown that high levels of skill formation can be achieved through on-the-job learning (see also Doornbos & Krak 2001). In general, it may be concluded that work teaches workers most effectively, and that practices, such as communication and symbolic patterns of behaviour at work circulate about the

job itself (Garrick 1999). These are important outcomes which are implicit in work activities and are learnt through engagement in these activities.

Though the approach, described above, is seen as an important one among the other approaches to learning, alone it can scarcely offer a comprehensive explanation of the phenomenon. Instead it gives a general and introductory picture of learning at work. It would, thus, be too easy to state that learning in the workplaces occurs informally without examining more properly of what this informal aspect consists. As Billett (2004a) argues, it is not appropriate to refer workplace learning experiences as being informal when they are, in fact, structured by historical and cultural practices and micro-social processes as well as intentional in the sense that they are often central to the continuity of work practice. Moreover, characterising workplaces or even educational institutions as being either formal or informal privilege the social and institutional systems. Doing so is to deny the very agency that individuals bring to these kinds of environments and which contributes to shaping much of their individual learning and, some would argue, also reshapes these institutions and systems themselves. So while conceptions of workplaces as informal, incidental and situated learning environments are helpful in distinguishing them from what goes on in educational institutions, they are problematic in the work context. There is need to go beyond such characterations and consider workplaces more broadly as learning environments. Moving on from the point about the privileging of the social and institutional systems in claims about formality and informality, the next section discusses workplaces from the perspective of the individual.

2.2 Experiences of an individual worker as a foundation for work and learning

Given that learning is embedded in the realities of workplace systems and processes, it can be argued that experience, and thus learning through experience, are also among the most important ways of learning in the workplace. Accordingly, an additional approach acknowledges that the basis of workplace learning lies primarily in experience, that is, the ways in which people make sense of situations they encounter in their daily lives (Marsick & Watkins 1990; Weick 1995). For workers this means, for instance, that working and learning are inseparable. The objective of the worker's activity is not to learn but to work and do the job. Yet learning is embedded in everyday problem-solving situations (Bereiter & Scardamalia 1993), in the accumulation of competencies, in learning through mistakes and in interactive negotiations with colleagues. Nonaka & Takeuchi (1995), for example, describe the process of knowledge production as going hand-in-hand with the experiential learning of a team, group or organisation. They emphasise the role of "tacit knowledge" in organisations and the importance of turning this implicit knowledge into

more explicit ways of knowing at the group and organisational levels. Billett (see e.g. 2004a) refers to the role of the engagement in everyday work activities as a means through which learning occurs. In particular, much of that learning is about the refinement and reinforcement of what has previously been experienced. Expertise arises from practice which hones and defines the skills of the individual, not one-off experiences. So, as well as encountering new tasks and new learning, a key attribute of workplace experiences is the opportunity to develop through processes of refinement and reinforcement. These processes are central to the conduct of expert practice, as is well elaborated in cognitive accounts of expertise.

A number of key theorists on learning from experience suggest that new learning begins with a trigger of surprise or discomfort that prompts intentional reflection on experience (Kolb 1984; Marsick & Watkins 1992). Until recently, the discussion concerning the role of experience in work-based learning has thus emphasized the importance of reflecting on experience in order to be able to connect it with theoretical (scientific or domain specific) knowledge (Bereiter & Scardamalia 1993; Boud & Miller 1996; Brookfield 1996; Fisher 2002; Malinen 2000). However, this does not necessarily involve any attention to how and where the experience in question was acquired (see Fenfick 2001a). More attention should thus be paid to the fact that to make experiences meaningful we also construct and interpret them (see also Merriam & Heuer 1996) in their natural settings, such as the workplace in the case of work, as they may have different meanings depending on individual goals and changing situations.

Consequently, it has been argued that less weight should be put on the role of reflection. Instead, working and learning has been seen as occurring more intuitively without the opportunity to think about what is actually happening at any given moment. Beckett (2001), for instance, describes workplace learning as 'hot action', referring to those frequent experiences in the workplace when, moment by moment, decisions are taken on the wing, as it were, case by case, and with the nagging doubt that they might be inadequate, hasty and inappropriate. The intention is to perform but also to do things right. In such a situation, learning is characterised as taking place through acting anticipatively and context-sensitively through constant negotiations about the contingencies and routines of the workplace. The basis of learning in the workplace is thus seen as the making of practical decisions and on the application of personal experience to the solving of specific problems or the performing of specific tasks using intuition and common sense (Gerber 2001) and making sensible judgements (see also Beckett & Hager 2000). Learning is perceived here as the accumulation of experience and with reflection taking place, if at all, only after (cf. Schön 1983: reflection-on-action) the task has been completed or the problem solved (e.g. Fisher 2002; Rasmussen 2002; Torraco 1999). Perhaps more importantly, this perspective brings the individual to the forefront. The individual's agency and ways of knowing become key components of the workplace as a learning environment. Consequently,

considerations of workplace pedagogy are needed to accommodate an agentic role for individuals (see Billett 2004b).

These individual perspectives on experiential learning (see Fenfick 2001b) show how knowledge emerges from the activities of interacting and participating in the community. Thus, knowing is inventive and entwined with doing (Lave 1988). It is typical for adult learners that they do not learn from experience, but that they learn while experiencing. Thus, dividing knowledge into the categories true or false is of little help; what is worth knowing and doing is defined by the particular situation (Lave 1993). Recent studies have also thrown up the concept of work process knowledge (see Boreham 2002), which is the knowledge continuously being produced in the workplace through the work process itself. This knowledge is characterised by its usefulness in the job; it includes the dimensions of both practical knowledge and theoretical understanding, and it is held collectively as well as individually. Here, according to Fisher (2002), experience is also embedded in doing. Experience is accumulated during practical doing and is sought in order to learn the prerequisites or the consequences of an action. The result of experience is thus knowledge about an action, which includes the relevant context, in a form that can immediately be put to use for the purpose of this action.

2.3 Working tasks and contexts as determinants of learning

In line with the view presented above, learning at work is context-bound, in so far as context is in part constructed by the individual. That is, the nature of learning in the workplace as situated and negotiated is widely accepted nowadays (e.g. Brown, Collins & Duguid 1989; Lave & Wenger 1991; Wenger 1998). Østerlund (1996), for instance, calls for learning to be seen as embedded in socially situated structures of ongoing practice and across the contexts of practices. Yet learning at work may need to be extended to include the principle that in specific contexts, through interaction, people create common interpretations and meanings, for instance about learning or competencies (Billett 1998; Henriksson 1999). Competence can be neither separated from the context in which the performance is expected to occur nor transferred from one context to another (Brown & Duguid 1991; Ellström 1997; Järvinen & Poikela 2001; Orr 1996; Sandberg 2000; Torraco 1999).

From the context point of view, learning at work can also be seen as participation in communities of practice (see Lave & Wenger 1991). Communities of practice are described as dualistic systems of participation (membership and interaction) and reification (instruments, documents, forms and points of focus created in a community), which determine, on one the hand, the interaction of the world and the experience of action in the world and, on the other hand, how meanings produced by the culture are negotiated (Wenger 1998). However, the negotiation of the context can be contested. One problem

with the community of practice approach is that such communities are often seen as benign. Yet, workplaces are often not like this. Instead, they are highly contested environments where opportunities to access activities and guidance are distributed unevenly across workers (see Billett 2001b). Workplace affordances are constituted and distributed by workplace hierarchies, group affiliations, personal relations, workplace cliques and cultural practices, and the kinds of activities in which individuals are able to or are requested to engage. Accordingly, organisational culture, the work itself and the role of colleagues may determine what is learned and what it is possible to learn (see also Karakowsky & McBey 1999).

The idea of work as context-bound activity may also be approached through the activity theory developed by Engeström (e.g. 2001). His basic unit of analysis is the activity system, meaning the complex interrelations between the individual and different groups or communities in the workplace connected by the division of labour and by established rules and procedures. Engeström and his colleagues (1995) have analysed learning at work as crossing boundaries between various contexts, as in the case of those inside an activity system or between systems themselves. In his more recent work (2001), he has described a new approach to the concept of expansive learning, which problematizes the fact that in organisational practices we are required to learn new forms of activity which are not yet in place. Engeström argues that the depiction of learning as vertical processes aimed at higher levels of competence is inadequate. A complementary process, horizontal or sideways learning and development, also needs to be conceptualised and both these processes taken into account in analysing learning at work. The activity theory approach has been criticised as implying that individuals either engage wholly or not at all in the activity system (see Billett 2005). Consequently, there is little in the activity system theory approach which accommodates different levels of participation or engagement with the social system as encapsulated in the activity system.

With respect to the importance of the contexts in which learning takes place, it has been stated (Ashton 2002) that the current study of workplace learning has narrowed the focus on how learning takes place down to a process of interaction between individuals and groups (see e.g. Engeström 2001; Eraut, Alderton, Cole & Senker 1998a, 1998b; Lave & Wenger 1991), thereby losing sight of what is learned and how the immediate work context shapes learning. However, it has been widely recognised (see e.g. Darrah 1995, 1996; Eraut 2002; Lave 1993; Marsick & Watkins 1992; Wenger 1998) that the large part of workplace learning is accomplished through participation in workplaces and is best understood by examining the relationship between practical work activities, the cultural and social relations of the workplace and the experience and social world of the participants (Evans & Rainbird 2002). Consequently, in order to better understand the processes of learning in the workplace it is time to move beyond a narrow focus on the process of interaction in the workplace itself and locate the worker's learning in the broader context of the relations of

production (see Ashton 2002). Also, the question of what is learned in different contexts should be asked.

2.4 Learning in the workplace as social and shared – collectivity

From what has been said above, it can be assumed that from the perspective of a worker, learning, the technical performance of work tasks, and the social life of the workplace are not separate elements of the work process (see Henriksson 2000). They are inherent and intertwined. As teamwork and networking become more widespread, more and more jobs come increasingly to involve social activities. Work as social interaction and teams and networking are central starting points also in current research on workplace learning, with many of those who study learning in work contexts seeing teams and work communities as the primary environment in which people learn at work (e.g. Boud & Miller 1996; Eraut et. al. 1998b; Evans & Rainbird 2002; Gerber 1998; Marsick & Watkins 1992; Wenger 1998). In many ways, what people learn at work and how they learn it are bound up with the social contexts and communities where work is carried out (Orr 1996; Rainbird, Fuller & Munro 2004; Sandberg 2000; Torraco 1999). Furthermore, it has been suggested that the most important learning situations associated with work activities involve shared problem-solving (Bereiter & Scardamalia 1993) where employees can construct a self-image and define their own abilities as workers in the context of a broader work community or team (e.g. Wenger 1998). Today, the manifold problem situations that must be resolved in working life presuppose networking, the continuous creation of new social practices, and creative approaches that suit different situations (Engeström et. al. 1995; Schön 1983). Here, a key concern is for the development of intersubjectivity, shared understanding between participants, which is the cherished goal of social cultural theories and underpins many of the assumptions about learning in education institutions, for instance.

However, investigations of what is known as contextual learning at work have so far largely been theoretical. There are as yet few concrete accounts of how learning and competent occupational activity take place in everyday social work situations (Eteläpelto & Collin 2004.) Researchers using ethnographic and ethnomethodological approaches, which would make more detailed analyses of the collaborative and contextual nature of learning at work possible, have similarly been in a minority in the research field (Gherardi 2001). Moreover, there has so far been little research on the collaborative dimension of work and the social atmosphere at work as factors in work-based learning among people preparing to enter an occupation. While the work community has been recognised as an important learning environment, researchers' specific interest is often in the technical performance of work tasks. As a result, the interactive aspects of the work process and the work done to foster a sense of community

may, in studies of learning at work, remain an obscure area unrelated to other dimensions of work as an activity.

Even though the role of other people in workplace learning has been studied, for instance, from the various viewpoints of communities of practice (Wenger 1998), knowing as culture (Nicolini, Gherardi & Yanow 2003) and activity systems (see e.g. Engeström et. al. 1995; Engeström 2001), it continues to lack empirical investigation that takes into account the numerous contexts as well as special nature of this kind of learning. Approaches to examining the reality of the contemporary workplace also continue to lack empirical studies on precisely what is being learned and how, via everyday collaborative practices (see Elkjaer 2003.) There is an even greater lack of approaches in which these practices are probed in a critical light and in a way which includes contradictions and conflicts (see e.g. Illeris 2002, 195) with a view to showing how the collective dynamics of teams could be need to enhance the possibility for development and renewal in organizations (Henriksson 2000).

Nevertheless, some observations on the social and collaborative dimension of learning as a factor in the work process are available. Recent research has shown, for instance, that identifying changes in group work, the way work is organized and the way jobs are designed can shed light on how learning occurs in the workplace (Eraut 2004; Rainbird et. al. 2004), across a range of situations and circumstances. The various contexts of work and learning (for instance, how work is organized) must, however, also be seen as a dynamic, temporally unfolding process accomplished through the ongoing rearrangement of structures in the participants' talk and bodies, and in the relevant artefacts, spaces and features of the material surroundings that are the objects of the participants' scrutiny (Goodwin 2000.) Consequently, in approaching practice and the learning in it, it should be remembered that the contexts of practice are not solely determined from outside (see e.g. ten Have & Psathas 1995). Instead, the relevant contexts for practices are also constantly being constructed anew both by the participants themselves and by the tasks they are called upon to perform. What the various kinds of settings and contexts within which workers act actually "do" is to provide the latter with frames which they can use to their advantage when designing their own activities and assessing those of others.

Whether interaction in the workplace is approached as taking place alongside practical actions as a cultural phenomenon (see e.g. Nicolini et. al. 2003; Yanow 2003) or as a constituent of everyday actions (Boden 1995; ten Have & Psathas 1995), the roles of interaction and talk have been enthroned as a focus of research efforts. Everyday work and learning in teams and groups is approached through ordinary, everyday work talk, as people are naturally prone to converse in certain settings, such as meetings, when passing in the corridor, or standing in office doorways (see Boden 1995; Granath, Arch, Adler & Lindahl 1995). Teams, especially, are seen (Middleton 1996) to be sites where team members give voice to contradictory and problematic aspects of team

practice. Incidental talk is used in achieving working solutions to anticipated problems.

In its most concrete forms learning in the workplace is argued to take place within the format of asking for and giving advice in relation to commonplace work activities. Reasonable and rational everyday activity is found to grow through the local logic of everyday talk, particularly in the intensity and intimacy of face-to-face interaction (Boden 1995). Doornbos, van Eekelen & Koopmans (2005), compared three different occupations, and showed that many kinds of interactive work situations can arise. They concluded that in all occupational groups the activity of giving specific information in response to the request for specific information occurs most frequently. Also a kind of "learning-by-walking-around" and the habit of dropping in on someone and asking what they are doing or discussing current problems has developed into an art in workplaces such as design companies (Granath et. al. 1995). In engineering and design work, especially, it has been noticed in recent years that different kinds of collaborative learning strategies between various worker groups have been introduced in order to manage everyday business. This is not necessarily a conscious company strategy but rather a result of the need to solve problems in projects (Granath et. al. 1995).

In addition, as mentioned above, the everyday life of work communities is not seen as wholly joyous and free of problems. Instead, there is an awareness that doing any job is increasingly coming to entail negotiations and exchanges of views that can at times lead also to conflicts and clashes (Billett 2002b) for which solutions must be found if work targets are to be achieved. Workplaces are not, thus, places where collaboration and participation in everyday practical activity occurs in a trouble-free zone. In the contemporary workplace, it has also been argued that work in general, including the work of designers and their learning through doing has become more a question of learning to talk about, negotiate and anticipate what to do in practice rather than just doing the job as such. Iedema and Scheeres (2003), for instance, describe this in terms of new discourse practices in which occupationals and professionals have to engage in discourse about their work with people they would not normally expect to do this with (see also Scheeres 2003). In general, this can also be seen in situations where work is done in teams, practice taking on a measure of discursive elements as responsibilities is also distributed among the team members. Sharrock and Button (1997), in their ethnomethodological study of engineers, also state that the need to perpetuate shared understanding among workers from different departments and projects stamps the work of engineers. There is a constant need to know "where we are collectively" in projects and "where we ought to be". This need to confront the contingencies of everyday work was resolved with the help of regular formal and informal reviews built, for example, into the project schedule and with the help of intergroup meetings where it was possible to compare, clarify and update team members' understandings about on-going projects.

As described in the sections above, workplace learning may be seen as connected with various themes, thus characterising its multifaceted nature as a phenomenon. It can thus be inferred from the review of the literature that in order to be able to understand the phenomenon of workplace learning as wholly and profoundly as possible, four features, at least, must be taken into account simultaneously. The first of those features is to see learning and work practices as intertwined and the goals of practice itself usually bypassing learning as such. Thus the aim of everyday work is less learning per se than getting one's allocated tasks done. The second feature concerns the importance of individuals' prior experiences for work and for learning through it as well as individuals' conceptions of how they interpret their experiences in different contexts, situations and in relation to their individual goals. The third characteristic is related to how the larger work context (team, organisation, culture) determines learning in the workplace. The last one concerns seeing learning as social and shared, but not however, wholly benign or conflict-free.

One promising attempt to capture the multifaceted nature of workplace learning is the process model of learning at work developed by Järvinen and Poikela (2001). In their model the relations between individuals, groups and organisations do not exist on different levels and hierarchies, which is the usual way of describing organizational learning. Instead, they approach these relations as flows and processes to which individuals and groups are bound in different ways and which together constitute the organisational entity. Consequently, in order to be able to better understand the learning taking place in design, the nature and context of designers' work are next described on the basis of the recent literature.

3 CONCEPTUALISING THE WORK OF PRODUCT DESIGNERS AND DEVELOPMENT ENGINEERS

Technical product design and development[1] has traditionally been perceived as solitary, individual work in which little cooperation takes place between designers from various disciplines and other fields. Within the tradition of cognitive science design activity has been described as an ill-defined and open problem domain (see Eteläpelto 1998, 51). Recent studies of design work show, however, that it would be better characterized as creative, visual, ill-defined, unstable and, above all, social and collaborative involving several other parties such as clients, and users, and marketing and production personnel (Baird, Moore & Jagodzinski 2000; Brown & Duguid 1992; Kolehmainen 2001; Rasmussen 2002; Rahikainen 2002). Therefore, technical product design and development work today can often be best described as multi-professional team work which aims to solve ill-defined and short-term problems. This acknowledges the shift from being seen as ill-defined solitary work conducted through individual inventive minds, to collective activity focused on responses to ill-defined tasks. Consequently, "the problem-solving" paradigm of design has been challenged by the paradigm of reflective practice championed by Schön (Lawson, Bassanino, Phiri & Worthington 2003). However, the reflective nature of the practice also encompasses collectivity, interaction and negotiation, as well as possible contestation within a collective process.

The focus of interest in this study is not to investigate design work as an area of expertise (cf. Eteläpelto 1998), but design engineers' learning during the design process. The purpose is to investigate how designers themselves see their practice and learning in the course of doing their jobs. Thus seeing designers' practice put in its real context, whether a team or a larger organization, would be a more justifiable approach to the nature of design work. The purpose is to render visible the interactional practices and processes

[1] Throughout this report the use of the terms designer, product designer, design engineer and development engineer refer to the same thing, i.e. to practitioners who are responsible for the practice of design and development in teams and organisations.

through which technological work is organized and learnt (see Button 1993). In this connection, a few of the main features of design work, based on recent studies are presented. According to recent ethnomethodological and ethnographic research, design and development work can be characterised as:

- a collaborative and "messy" practice rather than intentional planning or following a general problem solving procedure (e.g. Gedenryd 1998; Henderson 1999; Hyysalo 2001; Schuler & Namioka 1993).

- a common endeavour of design team rather than work built on individual designer's solitary efforts (Bødger & Grønbæk 1998; Brown & Duguid 1992; Sharrock & Button 1997).

- taking place within multi-professional teams and groups and within larger organizational contexts (Greenbaum & Kyng 1991; Eteläpelto 1998; Schuler & Namioka 1993; Schön 1987).

- seeking to take the product's everyday users and their work contexts into account during the participatory design process (Adler & Winograd 1992; Brown & Duguid 1992; Greenbaum & Kyng 1991; Jaikumar & Bohn 1992; Miettinen, Hyysalo, Lehenkari & Hasu (eds.) 2003; Schuler & Namioka 1993).

Even though these four features are presented here as separate items, they are however, parts of a whole which are difficult to distinguish from each other during the design process because they are interwoven and intermingled. Although the practice of design and development work may differ in many respective, the two terms are used in this study interchangeably. The reason for this is that they both are held to be on-going creative activities and that the process of bringing a product from its inceptions as a set of vague ideas to a marketable good is rarely a linear one. In the next sections, these qualities of contemporary designers' work are elaborated in order to present a coherent and comprehensive account of the attributes of this work in order to learn how to appraise them.

3.1 Design and development as messy practice in a field of ill-defined problems

The first feature, which describes the work of engineers from an ethnographical perspective, challenges the idealized or reductionist descriptions of the design process as one of linear processes of cognitive problem-solving (e.g. Bucciarelli 1994, 2003; Henderson 1999; Sharrock & Button 1997; Rasmussen 2002; Schön 1987). Instead, in these studies design practices are described fundamentally

"messy". That is the processes of design work is characterised more by backward and forward than linear iterations. The discrepancy between the idealized design process and actual practice is most visible in the various problems and misuses of software Cad/Cam programs that support the aspects of design work. This may, however, mean that various other processes in design work may remain invisible. Gedenryd (1998) has criticized both design research and cognitive science as unable alone to capture the authentic activities of designers and the physical environment surrounding these activities. He analysed most of the design theories and concludes that the model of intentional planning, execution and evaluation seems to pervade most of them, while none of the well-known ethnographic accounts of design work support such a rational picture of cognition and practice in design (see also Eteläpelto 1998, 51–55; Mawson 2003; Baird et. al. 2000). Design tasks, for instance, are difficult to fully disaggregate, break up or reduce to subtasks that can be independently analysed and appraised (Bucciarelli 2003.) However, linear design models may be seen to have the function of keeping fuzzy projects somehow within the designer's grasp and driving the design project forward (see Hyysalo 2001). That is, they might provide an overall basis for directing the creative activity of designers.

Instead of seeing design as a linear and idealised procedure, it would be better to see it as exploring both the problem and its solutions at the same time. The work of design engineers concerns very ill-defined problems; these are carefully summarised by Rahikainen (2002) in her analysis of problem-solving process in product development. The problems to be solved are large and complex by nature and usually there are no right or wrong answers, only worse or better options, depending on the criteria used. Hence, problem-solving is characterized by limitations and constraints. The cost of being wrong during the process can also be high, as there may be no genuine feedback available during it; unless it may only come after the product is ready. Product development is usually carried out by group of people and, possibly involving a client (Rahikainen 2002, 42).

It is thus typical of design practice that these problems to be solved are not visible within the actual process, but usually become so only when the job proceeds (e.g. Schön 1987). This is a feature of design work which it is not possible to anticipate but which one has to learn to live with as part and parcel of the various ambivalences and constraints of work (Sharrock & Button 1997; Wagner 1997). It is especially typical of designers' work that all the technical options must be kept open as long as possible while, at the same time, fundamental solutions must be found in time. In general, the work of design engineers, as they perceive it, is one of groping in the dark, and due to the uncertain flow of the design process, stressful. The breakthrough solutions may be found only in the end of the design process irrespective of the hard work done along the way. Consequently, the design process can be considered as a process where learning takes place in experiencing something which does not yet exist, and by exploring the interdependence of the problem and possible

solutions (Eteläpelto 1998, 54–55.) In particular, because design work necessarily engages designers in generating novel solutions, much of the learning that arises through the work might be "new" learning for them.

In addition to the ill-defined nature of the problems of design work, another important feature of messy design practice is that it is highly visual and creative (Henderson 1999; Kolehmainen 2001; Rasmussen 2002). Because visual practices are so important to problem solving, design engineers find ways to shield these practices from the formalizing structures of computer graphics systems or to mediate them through mixed-use practices and hence create a split between company-dictated procedures and informal work practices (Henderson 1999, 5.) In ethnomethodological studies on technical work practices in general, an important approach to design, in addition to seeing it as an ill-defined field of problems to be solved, is, for the designer to take a practical orientation, such as how much work is to be done, what things are required, how many people need to be involved or how much time is available to complete a job (Sharrock & Anderson 1993).

3.2 Design work as an effort of the team, group or network

The work of designers and developers is probably becoming more and more a team effort. This is the case at least in the multidisciplinary teams of mechanical, electronics and software designers, who are developing new kinds of products and services for future users' needs. For instance, Rahikainen (2002, 61) proposes that there are a wide range of problems that simply cannot be solved by individuals alone but that design and development is a task that requires a high level of experience not possessed by any single person alone. For example, one study found that in order to work efficiently a team has to find a language which is already shared to some extent by team members from different areas of expertise. It is a team of designers which together engages in the tasks of circulating knowledge, which reproduces the production process, checks how things are going, that individuals are doing their respective jobs, and so on (Harper & Hughes 1993). Designers' work can also be described as not only dependent on the work of other team members in the same office but also on a range of other individuals and teams in other organizations (McGormick 2004; see also the work of architects in Luff & Heath 1993). Hence, collectivity within the work team and with those outside it is becoming increasingly a feature of design practices. Furthermore, collaboration among various groupings and networks (e.g. Nardi, Whittaker & Schwarz 2002) and the negotiations that take place in such contexts are a pervasive element of all problem-solving in working life and also for the work of designers (see also Granath 1991).

In technical design, a network comprises, in addition to the design team, on the one hand, the customers and, on the other hand, the people who will

implement the designs, that is the workers responsible for making the eventual products (see e.g. Rasmussen 2002.) Equally, as Kolehmainen (2001, 2004) has found out, in high-tech IT firms constantly changing project groups include, in addition to co-workers, a number of clients who may take part in the design process. Further, co-operation with other IT business service organizations and with suppliers and trainers and researchers is seen very important (Kolehmainen 2001, 61–75). To approach social interaction at work even more broadly, an individual designer may be seen as part of an active process of shaping new ideas, methods and products in a continuous dialogue with his or her peers in the design team and with other participants in the social network that constitutes the design context. Furthermore, designers are often engaged in dialogue with the design situation itself which, at its best, can lead the whole team of designers to listen to each other during the design process as various solutions and options are reflected upon (Rasmussen 2002). This kind of interaction can lead to intersubjectivity or shared understanding between the interlocutors.

As indicated above, teamwork is positioned as becoming of greater importance as design has become more and more related to other kinds of activities going on in companies (e.g. teamwork between designers and members of other departments). Even though many studies of design teamwork have approached the topic almost solely from a management perspective, the ability to collaborate has been raised as one of the key qualities of a competent designer in these studies as well (Rasmussen 2002.) The studies stress, however, that design in teams is not team-based problem-solving only, unless the design team contains individuals with various social roles and relationships that affect the design process in some way. As noted above, discussions between interlocutors can assist this process. Visual representations (see Henderson 1999), such as sketches and mock-ups, for example, also serves as a valuable base for disseminating ideas and knitting together people who have different interests and experiences, as is usually the case in larger projects involving inputs from customers and subcontractors etc. (see also Medway & Clark 2003; Newton 2004). This is because in engineering and design the concrete representations will often be a set of drawings and written specifications. Thus the design process can also be characterised as a dynamic interrelationship between people, things and representations of things.

As indicated above, workplaces are not, however, sites in which collaboration and participation in everyday practical activity occur without dissension or possible contestation. Collaboration between teams and organizations will include many conflicts caused by structural organizational factors or problems constituted from inside team practice (Sharrock & Button 1997). Upon investigating engineers' work Sharrock and Button (1997), for instance, found that in order to ensure that design projects are accomplished and problems resolved along the way, many contingencies resulting from collaboration must be faced. At the same time, however, social solidarity across the project or between different teams was sustained in many ways. Another

interesting contingency mentioned by Rasmussen (2002) is that even though designers may be involved in intensive electronic dialogue with colleagues and various networks in other companies around the world, they may not have a slightest idea about what their colleagues sitting next to them are doing. The risk of reduced, (or no) communication between members of different design teams is that a lot of duplication may occur and that designers may have a feeling of isolation despite their membership of a team or organization.

3.3 Situated use of knowledge about users and their working contexts

Traditionally, analysis of product design work has focussed on technical characteristics only. That is, it has focused on the problem-solving processes that individuals engage in, rather than understanding the collectivity of the design process, and the necessary inclusion of interlocutors and partners. The underlying idea has been that designers and engineers can, given information about prospective users, build a product for those users' needs. The idea has been that, after all, users will adapt to the new technology if they are properly taught to use it correctly (see Miettinen et. al. 2003). Recently, however, users have begun to be seen as competent participants in the design process as well (e.g. Adler & Winograd 1992; Greenbaum & Kyng 1991; Schuler & Namioka 1993). From investigating the products' usability (usually in the laboratory) so called user-centered design and contextual design has begun to analyse practitioners' current work practices more widely in order to find real bottlenecks in practice and thereby be able to support the design (Suchman 2001 sited in Miettinen et. al. 2003). A further step is participatory design (see Schuler & Namioka 1993) where the aim is continuously to develop users' work circumstances and practices with the help of the design (see also Bødker & Grønbæk 1998). Thus design is not only a matter of observations of users' practices but negotiations and cooperative meetings with users throughout the whole process, and even after the product has been brought into existence.

The recent studies also emphasise that the design process needs to start with an understanding of the use situation. Greenbaum and Kyng (1991) note that traditional system development advocates beginning with the identification of "the problem". However, problems out of context may have little meaning. Millar, Demaid and Quintas (1997) in their study of trans-organizational innovation in the area of information and communication technologies note that product innovation and development is contextually situated and that interaction is an intensive process which involves mutual interaction between characteristics of the product and those of the context. This means that in order to be able to design, there is a need to understand, not only the contexts of actual use but also the wider organizational context of the users (Brown & Duguid 1992; Rasmussen 2002). When a computer system, for

example, is introduced within an organization, it may change the organization's practices and modes of interaction. Likewise, design products such as computer systems are not static entities, but rather systems that adapt as they are used. Therefore, the dynamic process of ongoing change means that designers need better to understand the organization they are working for and design for this change (Greenbaum & Kyng 1991; Henderson 1999).

Even though user-centred and participatory design has been recognized as important and significant, it has not been used as much as it might be possible and also has faced some major barriers in practice. As perhaps the most known model of participatory design, UTOPIA in Scandinavia (see Ehn 1988, 1992) showed there are not, at least as yet, enough resources for long-running co-operation between professionals, social scientists and researchers in designing products for end-users' needs (see also Miettinen et. al. 2003). The line between product development personnel and users is still difficult to cross, and developers tend to be orientated more towards technical aspects and tend inadequately to understand the prerequisites of product implementation.

3.4 Designers' and engineers' learning at work

As stated above, learning in the workplace has not been much approached as taking place in specific contexts of occupations and tasks, nor have the general characteristics of design work been investigated in relation to designers' learning as such. Nevertheless, what has been described above about learning at work in general and the nature of design and development work is in line with a few studies recently conducted in the area of engineers' learning. Senker (2000) investigated the work of engineers and technicians in companies whose task was to develop engineering products and who worked in an environment of rapid technological change. Like Lave (1993) and others before him, he found that, at a general level, working and learning cannot be separated. Instead, the complexity and variability of engineers' learning processes and the extent to which most are embedded in day-to-day work is considerable. More concretely, learning seems to arise largely out of the challenge posed by work, for example, solving problems, improving quality, getting things done, coping with change, and out of interaction with colleagues and customers. Learning at work can be described as taking place through and from experiences gained from various sources and contexts, for instance, from past mistakes. Senker (2000) sums up by saying that many engineers' working lives could be described as a "continual apprenticeship" in which all learning does not necessarily take place at the initial stages of working life but throughout it. In doing so, he provides another term for thinking about a tradition which has long existed in the Nordic countries about life-long learning, and which has been popularised and embodied in various official policies (see Angervall & Thång 2003).

An additional view of workplace learning is offered by Rasmussen (2002) who studied designers' work in Denmark. On the basis of in-depth interviews with 26 industrial designers, he emphasizes, in addition to the experiential and social aspects of learning, the importance of the aspects of visuality and creativity for designers' work and learning. Design practice, as well as the learning in it, requires the freedom to organize and carry out one's work. It also depends on the availability of time to rebuild, modify and reorganize one's daily work experiences through formal and informal dialogue with colleagues. He concludes, however, that the prerequisites of learning in the workplace are seriously restricted, if there is not the possibility of communication between different people within the company. A shared understanding of each others' various roles at work or the free flow of information across the contexts are needed for the job to be done.

As stated above, designers' work can be characterised as a challenging and messy practice where multi-professional teams and larger networks act within the contexts of everyday users' needs and demands. Since the learning of designers has also been claimed to include coping with constant changes in the practical sphere of work as well as solving multi-faceted problems, it would be very important to conduct proper investigations into the field of learning at work in general to be able to compare learning in different work contexts and learn what kinds of common and shared features of learning through work there might be.

Consequently, workplace learning as a phenomenon seems to be made up of elements which concern the work practices per se and how workers learn through their work experiences, and how these experiences simultaneously define their individual agency, as well as how social and communal elements have effects on how learning takes place and what kind of learning is possible in various environments in the first place. Following from this conclusion, the present study adopted a multiple perspective on the practices of work, design work especially, and the ways learning may take place in the course of those practices. Empirical interest was thus focused on how the designers themselves perceived their practice and learning through that practice. Further, the social and collective elements of learning were investigated more closely. The next chapter provides a more precise description of the aims of this research together with the specific research questions addressed.

4 THE AIMS AND PROGRESS OF THE RESEARCH

As a phenomenon workplace learning is multi-faceted and il-defined, and is still in its relative infancy as an area of research. So far the studies conducted in the field have mostly drawn on the cognitive research tradition utilising approaches, methods and concepts borrowed from the formal education system (see e.g. Hager 2004b). Thus, in spite of increasing interest in the area of workplace learning, it continues to lack the kind of empirical investigation that takes into account the individual learner perspective and the numerous contexts involved and special nature of this kind of learning (Evans & Rainbird 2002; Orr 1996; Rainbird et. al. 2004; Sandberg 2000; Torraco 1999). In addition, everyday life and learning at work is sometimes assumed to be benign and uncontested, despite, a growing awareness that doing any job is increasingly coming to entail negotiations and exchanges of views that can at times also lead to conflict and clashes (Billett 2002b).

To study the phenomenon of workplace learning presents a methodological challenge. Large-scale studies and questionnaires, producing quantitative information, are not alone sufficient to understand the learning that takes place in the work context (e.g. Boud et. al. 1998; Darrah, 1995; Eraut et. al. 1998b; Orr 1996). Accordingly, this study utilised interpretative and qualitative approaches, process-oriented methods and detailed descriptions of work in natural settings, such as case studies and workplace ethnographies (Eraut et. al. 1998b; Henriksson 1999; Karakowsky & McBey 1999; Sandberg 1994; Torraco 1999). These are the approaches that are most suited to understanding relations in the workplace and how individuals participate in them and thus engage in learning.

The general aim of this study is to describe and understand designers' learning at work. The study takes an ethnographic approach to learning at work, one which sees its object as context-bound, participative and shared, but also connected to individual experience. Thus, the primary aim is also to bring together those aspects of individual and social learning which seem to be present in everyday work practices and on-the-job learning. Apart from the lack of combined approaches to the phenomenon of workplace learning, the need to

use complementary research methods has also been called for (for more details see chapter 5). Hence the adaptation of an ethnographic approach is chosen in this study. The study progressed in the manner typical of an ethnographic methodology. The ethnographic process is usually described as a funnel down which the research travels from its starting points of several unclear or general themes to more focussed and organized questions (see e.g. Silverman 2001). Ethnographic research, like the present for example, can also be described as a process of continuous interaction between background ideas and data, and not solely as a theory-driven enterprise.

Due to the complex nature of learning in the workplace as mapped out above, the study design is based on a multiple methods approach. The first aim of the entire research process was to capture design engineers' own conceptions and experiences of their learning in authentic work contexts as well as describe their work and learning as shared practice. Thus data-driven methods of collecting materials and analysing them were chosen. Throughout, the research was conducted within ethnographic framework on the bases of observations and interviews. The study design is described in figure 1. Main results of the research project have been presented in five articles written during its course, i.e. the period 2001–2004. They are appended to this report. The research tasks, materials and methods of analysis of each of the five articles are briefly described in table 1. Methodological choices and the grounds for making them are described more precisely in chapter 5.

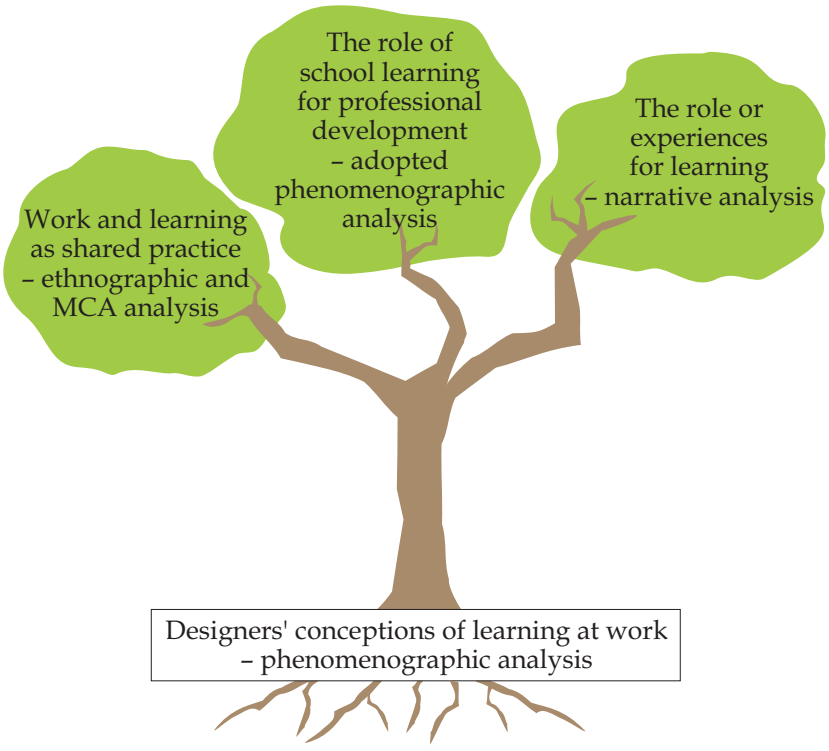

FIGURE 1 Study design

4.1 Study design and procedure

Since the point of departure of the entire research effort was to map design engineers' conceptions of learning at work, the study commenced with a search for the relevant data. Thus, the first research problem was framed as follows:

1) What kinds of conceptions do design engineers have of learning at work?

To gain a general impression of designers' conception of learning at work, a phenomenographic analysis of interview material was conducted. The themes taken up in the interviews with the designers were their tasks they were currently working on, the competencies needed in design work, challenging situations at work, the organisational atmosphere and culture of the workplace, and learning at work. The questions posed in the interviews can be found in appendix 1. The findings of this analysis are reported in article I.

The results of this first, phenomenographic analytical phase indicated that learning in the workplace can take both various and mixed forms, which merited closer investigation. Consequently, one of the most interesting findings was that the role of previous work experience appeared to be essential for designers' learning. The second question, following from the phenomenographic analysis was, thus:

2) What role does previous work experience have in on-the-job learning in the domain of design work?

This question was addressed by a narrative analysis of designers' stories as those were told in the interviews and reported in article II. It was noticed, however, that collective ways of acting activity and interaction deserved closer investigation as well. So far the analysis had been based on individual experiences extracted from the interviews; hence a more objective picture of designers' learning was needed on. Accordingly, the third question was:

3) How do engineers learn through shared practices of design and development work?

Work tasks and their contexts define the ways in which learning is able to take place. It was possible to approach collective ways of accomplishing jobs and learning while doing so as if from outside by ethnographic analysis of the designers' discussions and meetings during their everyday practice. Accordingly, the designers' shared practice and learning is reported in articles III and IV.

In addition to the approaches to designers' work and learning described above, the role of formal education and ways of integrating theoretical and

practical knowledge in designers' practice was investigated on the basis of the interviews. The results of this study are presented in article V, which also compares the experiences of workers and students.

4.2 Structure of the report

The purpose of this report is to summarize and review the work done for each article. Due to the qualitative nature of the research, the structure of this report also adapts an ethnographic approach in describing the process and the results of the research. It is based on five articles published (or submitted) in the course of the research process. Three of them were written by the present author alone and two were co-authored. In co-athored articles IV and V the data which concerns designers' experiences is gathered and analysed by the author while the data concerning students and youth workers experiences is analysed by the second authors. In both articles this data has also been compared by all the authors. For more detailed description see the articles IV and V in question.

Each article focuses on a specific empirical phase of the process (see table 1). At the same time the report aims to be an independent publication; however the articles provide a more profound treatment of the themes and results. The report also reviews the ideas underlying studies in the area of workplace learning in general and nature of the technical design and engineering work (see chapters 2 and 3). Contextual information concerning the jobs done by the designers and the methodological choices (chapter 5) and results of the studies are summarised and reflected on (chapter 6). In addition, the report seeks to contribute to the current discussion in the area of workplace learning by building a synthesis and redefinition of designers' learning in the workplace (chapter 6). The discussion in chapter 7 also makes practical suggestions for realizing learning possibilities in the workplaces and in designing and conducting, for instance, on-the-job learning periods as part of vocational education.

TABLE 1 A brief description of the specific research tasks and the materials and analytical methods used in each article

Research tasks and problems	Materials	Analysis	Article
1. What kinds of conceptions do design engineers have of learning at work?	Thematic interviews with eighteen product designers and development engineers from two companies.	Phenomenographic analysis	I Development engineers' conceptions of learning at work (2002)
1. What role does experience have in on-the-job learning in design work? 2. What is learned through experience? 3. Why is learning through experience an important way of learning in design work?	Thematic interviews with eighteen product designers and development engineers from two companies.	Narrative analysis.	II The role of experiences for development engineers' work and learning (2004)
1. What does the everyday shared practice look like? 2. What kinds of contradictory aims and demands can practice include? 3. What and how is it possible to learn through shared practices of design work?	Observations, field notes and transcribed team meetings and discussions between employees.	Ethnographic analysis.	III Development engineers' work and learning as shared practice (2005)
1. How is team interaction sustained and a sense of community maintained in the work process? 2. What kinds of mechanisms of knowledge sharing can be found between workers? 3. What is shared problem solving like in team interaction?	Observations, field notes and transcribed team meetings and discussions between employees.	Ethnographic and adopted membership categorization analysis.	IV Interaction Among Employees – How does learning take place in the social communities of the workplace and how might such learning be supervised? (2005)
1. How do employees and students see the role of school learning in the workplace for their professional development? 2. How do employees and students see the role of theory and practice in learning at work? 3. How do employees and students see education and work as contexts for learning?	Thematic interviews with eighteen product designers and development engineers from two companies.	Adopted phenomenographic analysis.	V Integrating theory and practice? Employees' and students' experiences of learning at work (2003)

5 INVESTIGATING DESIGNERS WORK AND LEARNING

5.1 Ethnographic approach to study learning in the workplace

Since workplace learning is multi-faceted and ill-defined as a phenomenon and it is still in its relative infancy as an area of research, a holistic methodological approach comprising both interviews and observations is adopted for this study. At the commencement of this research process there was a lively debate in progress about the most suitable methodology to study workplace learning, which still continues. Large scale studies and questionnaires, producing quantitative information, are held not to be sufficient to appraise the learning that takes place in the work context or the processes of that learning (e.g. Boud et. al. 1998; Darrah 1995; Eraut et. al. 1998b; Orr 1996). Instead, there is a need to examine learning at work according to how the actors themselves perceive learning (see e.g. Garrick 1998; 1999). This is because, beyond the affordances of the workplace (see e.g. Billett 2004a), which can be appraised through observation and interview, is necessary to understand from participants perspective how they construe those affordances and their influences on their learning, as well as the agency which individuals bring to workplace as a learning environment. Only through the perspective of the learners can these processes be fully understood. Accordingly, it was argued that qualitative and process oriented ways of deriving authentic information from workers' own experiences concerning their learning were selected as best meeting the challenge. More interpretative approaches, process-oriented methods and detailed descriptions of work in natural settings, such as case studies and workplace ethnographies were called for (Eraut et. al. 1998b; Henriksson 1999; Karakowsky & McBey 1999; Sandberg 1994; Torraco 1999). The deliberations about methods also identified the need for discursive approaches for the analysis of data within the use of qualitative and narrative methods in specific contexts (Bouwen 1998).

Consequently, the ethnographic approach with its use of mixed and qualitative methods for data gathering was selected to identify how designers themselves perceive their learning during their everyday activities. The purpose was also to gain a wider understanding of the contextual aspects of work which may have connections with learning or, at least, the possibility of learning. Even though ethnographic methods have not been widely used in investigating workplace learning until recently, they have been widely applied in the area of work and organization research (see e.g. Brown & Duguid 2001; Darrah 1996; Gherardi 2001; Engeström 2001; Orr 1996; Schön 1983; Smith 2001; Suchman 1998; Wenger 1998). Seen from the workplace learning point of view, these studies have been helpful in understanding the demands of various jobs and the competence and expertise needed in these jobs. Learning which occurs in the work context has not been directly studied, however. Nonetheless, that by combining different kinds of materials and analyses within ethnographic framework it is possible to interpret and understand some aspects of the kinds of learning or professional development needed in various areas of working life (see e.g. Wenger 1998). The importance of the work ethnographies conducted so far lies in that they have problematized what we often take for granted without being able to see the ordinary routines and complexities of work practices as sites of learning. In general, the aim of ethnography can be described as follows:

> "Ethnography is the study of people in naturally occurring settings of "fields" by means of methods which capture their social meanings and ordinary activities, involving the researcher participating directly in the setting, if not also the activities, in order to collect data in a systematic manner but without meaning being imposed on them externally" (Brewer 2000, 10.)

Following this advice, the purpose of the ethnographical approach adapted in this study was to show how various social practices on the part of designers can be understood from outside, i.e. seen as a stranger culture. In addition, the purpose was to understand the different meanings attached to learning occasions by the participants (see Hammersley & Atkinson 1995; Silverman 2001; Brewer 2000; Fetterman 1998). The participants in the targeted workplaces were approached by asking what events taking place in it could be seen as learning in everyday practice. The purpose was not thus to abstract people from everyday contexts. On the contrary, the aim was to see designers' learning through their activities and skills (see e.g. Silverman 2001, 53). Hence the purpose was not to approach learning in the workplace from theory-driven perspective, but to use a data-driven methodology in describing and understanding both how the employees themselves see their practice and learning, and what this practical learning may look like from the more subjective point of view of the learners acting in the setting and their work. An ethnographic methodology allows the researcher to combine the "subjective" and "objective". Since the meanings attributed to one's experience always are subjective (gained for instance from interviews), more objective point of views

(by observation) have been seen as necessary to widen interpretations and to gain as holistic picture as possible of the phenomenon under study. Combining the objective and subjective points of view at a methodological level also presents an opportunity to reveal possible contradictions between what the designers themselves perceive and how their practice and learning in it are ultimately manifested. With the help of the researcher's interpretations gained from direct observations the different voices in organizational rhetoric may also be heard.

Therefore, in this study, observation of workers' practice was combined with interviews with the workers. This is very typical in ethnographic study, although data is more usually gathered by means of observations alone (Atkinson & Hammersley 1998, 110–111). However, interviews were also used to obtain designers' own conceptions about their learning. Thus, following the ideas underlying ethnographic methodology, access to the actors' own accounts has been one of the starting points of this study as have their natural work settings, which have been investigated as social contexts supplying the meanings given to learning (Brewer 2000, 34–35). The analytical methods used are described in more detail in the following sections.

Not only in ethnographic research, but in any research, the question is whether the results of the research are artefacts of the researcher's presence and the inevitable influence of the research process (Davies 1999, 3). One of the most important conditions for "good" ethnographic research is to be as reflexive (broadly defined as turning back on oneself) as possible from the initial selection of topics and methods to writing the final ethnographic report (Brewer 2000; Davies 1999; Hammersley 1992; Hammersley & Atkinson 1995). So for instance, describing and arguing for methods used along the research process would be one means for confirming the plausibility of the methods used and interpretations made. This postmodern reflexive ethnography abandons both the claim that "reality" can be accurately represented ethnographically and the criteria by which ethnography's truth claims could be assessed. However, "post postmodern ethnography" (Brewer 2000, 48–55) argues that complete relativism and scepticism can be moderated by grounding the practice of the method in a surer methodological foundation than naturalism. This means that it is essential to evaluate critically the wider relevance of the setting and the topic, and identify the theoretical framework as well as establish one's integrity as researcher and author.

In addition, establishing the authority of the data and showing the complexity and context-boundedness of the data form the criteria for good ethnographic practice (Atkinson & Hammersley 1998; Brewer 2000, 53–54). As a researcher, I have thus attempted to be reflexive concerning my choices throughout this report and especially in this methodological section. It should be remembered, however, that I may have neglected many noteworthy and important views. A deeper methodological discussion on the plausibility and ethical aspects of this research project continues in the discussion section (see chapter 7) of this report.

By reflecting on and proposing the various choices I have made in conducting this research project, it is possible to discuss, for instance, why I have ended up using ethnographic methods and how I might have done things differently. First of all, studies conducted with ethnographic methods in workplace contexts are still rather scarce in the domain of adult education and especially in the field of workplace learning. As a researcher I would argue, however, that whatever the research aim may be, one should always look for most suitable methods to reach that aim. In this study, thus, an ethnographic approach was chosen to answer the research questions and to understand both the individual and social aspects of learning at work. It may also be problematized whether it should have more closely bound to a specific theoretical approach rather than being a data-driven enterprise. I wanted to investigate designers' own views and experiences of learning in the work contexts by a data-driven method. Conducting research this way recognizes that the actors themselves are the best informants to speak about the phenomenon of workplace learning and that their views are essential to understanding it.

5.2 The subjects and the contexts of the study

In view of the increasing interest being shown in the work and expertise of symbolic analysts (see e.g. Reich 1991) in identifying, solving and brokering problems, engineers and designers in this field were chosen as the subjects of the study. In fact, the number of ill-defined occupations is on the increase in Finland (Castells 2000; Zuboff 1988), which means that the demands for development and learning in these domains will assume even more importance in the future (Eteläpelto & Light 1999). This is because the contemporary era has been described as the emergence of information society, knowledge society or network society which all has and obviously continues to lead substantial changes in work and labour organisation as well as in organisational forms that structure work processes in new ways (Blackler 1995; Heiskanen 2004). At the time of deciding the research subject and the participant organizations it was posed that the work of design and development engineers would provide a suitable example of the work in which high-level and diversified expertise is needed to accomplish everyday practice. It was also assumed that the rapid changes in organizing work and new demands for competences would challenge the learning of the workers. Therefore work labelled as high-technology design was chosen as the research target. In the beginning of the year 2000, which was a time of economic boom in Finland, it was presumed that finding companies which would be interested in co-operating in such an approach would be relatively unproblematic.

However, in conducting ethnographic research there are a few critical phases, such as obtaining and entering the setting (e.g. Fetterman 1998;

Hammersley & Atkinson 1995; Schwartzman 1993; Silverman 2001; Smith 2001). After a couple of unsuccessful attempts to find organizations interested in co-operating with me, I finally found two firms on the basis of preliminary exchanges via e-mail. Hence the final choice of these two companies was inevitably based on the fact that they were the only ones willing to co-operate with me and allow me to enter their organisations as an outsider observer. In addition, in order to gain entry to one of the companies, an ancillary study for their own purposes had to be conducted regarding the development of their induction practices for employees. The other company, conversely, allowed me to conduct observations without any special conditions.

After agreeing to let me enter their organizations, I negotiated with the so called "gatekeepers" (e.g. human recourse manager and line manager) about appropriate groups of people for observations and interviews and about the persons who I would contact and work with when on-site. According to the information given me, all the workers were willing to take part in the study. Thanks to the initial efforts made to enter the settings, co-operation with workers and other quarters was quite unproblematic thereafter (c.f. Smith 1997). However, as in so many organizational ethnographic studies conducted before this one, field work is permeated with the conflict between what is theoretically desirable and what is practically possible. Often, there is a conflict between the processes of research which seeks to open issues at hand the management of access to information which seeks to control that access. Nevertheless, the two workplaces agreed to participate in the study. They are respectively referred to as Industrial Workstations (company A in articles) and Electronics Design (company B in articles).

Participants of the study

As part of the ethnographic framework of this study all the materials needed were collected through observations and interviews in two high tech companies in central Finland. Two groups of workers, one in each of two workplaces, were observed and interviewed in spring and autumn 2000, respectively. In both companies the observations were carried out for 5 to 6 weeks after which the interviews were conducted. The workers, all male, ranged from 22 to 58 years in age, numbered 18 in total. Thirteen of them had been educated as engineers and three as technicians, and two of them had a university degree. Five of the participants had more than 20 years of work experience and at least ten years of experience in design. Four were employed in a supervisory role (team leaders) and had at least ten years of work experience. The remainder had one to five years of design experience and, in a few cases only, very limited experience in the company in which they were currently working. Table 2 presents data about subjects. The left-hand column indicates the two workplaces. As noted in the second column from the left, there were ten participants in Industrial Workstations and eight participants from Electronics Design. This column also indicates they are pseudonyms and age in years. The middle column indicates

the highest level of education[2] participation for each of the participants. The column second from right indicates their position in the workplace at the time of the research. The right-hand column indicates the years of work experience in technique and design and within this company.

TABLE 2 Demographics of the subjects of the study

	pseudonym (age in years)	Highest level of educational participation	positions/tasks	work experience in technique/in this company (years)
Industrial Workstations (company A)	Lasse 35	technical college	team leader	12/12
	Arttu 29	technical college	product designer	8/3
	Erkki 58	vocational school	product designer	35/17
	Marko 26	polytechnic	product designer	2/5 months
	Juhani 33	technical college	team leader	11/10
	Mikko 57	vocational school	product designer	36/19
	Sulo 58	technical college	price-fixer	38/27
	Jouni 26	technical college	development engineer	8/6
Electronics Design (company B)	Taneli 24	polytechnic	software designer/trainee	5/5 months
	Petri 25	university/electronics	software designer line manager	2/2
	Jarkko 34	technical college	mechanical	10/4
	Jussi 30	technical college	designer	11/3
	Vesa 28	polytechnic	mechanical designer	4/1
	Juha 22	polytechnic	component	1/2 months
	Antti 36	technical university	supplier/trainee	9/3 months
	Tuomo 46	technical college	head of the team electronics	21/2 months
	Simo 36	university/electronics	designer	15/2
	Jouko 36	university/physics	electronics designer	16/1
			electronics designer	

Work and learning contexts

Industrial Workstations is an international supplier of industrial workstations and flexible production systems, Electronics Design services to the electronics manufacturing. In both of these fields job domains are typically ill-defined. The employees in both enterprises work under the title of product designer or

[2] In Finnish school system engineers are usually educated at polytechnical level, i.e. Ammatillinen korkeakoulu in Finnish. However, as noticed in table 2, the background education of the subjects of this study may be from technical school to university. Due to the variety of the designers' background education in this study; they are referred as *vocational* as a broader term.

development engineer in a product development and design team. These jobs involve many different tasks and require competencies in various areas. As Jaikumar and Bohn (1992) point out, in today's manufacturing environment, knowledge of procedures is incomplete, problematic situations change constantly and solutions are typically of short duration. Designing and producing products tailored to customers' needs means facing unexpected and challenging situations every day. To be beneficial, work needs to be done co-operatively by both users and designers (see also Bødker & Grønbæk 1998). The best possible solutions to customers' needs must be sought individually, usually with only little reference to past cases (see also chapter 3). This is because new and challenging working occasions are usually encountered unanticipated and solutions must be found quickly. This in turn makes the job even more challenging. A detailed description of the job characteristics of the two companies is presented in table 3. The practices are illuminated through a consideration of: Business area, Clients, Services, Organisation, Cooperation and Characteristics of the job. These practices were identified through a process of observation and field notes. They are the practices which may best describe also the differences of the organisations under study.

TABLE 3 Characteristics of the work in two companies

	Industrial Workstations (n = 8)	**Electronics Design (n = 10)**
Business area	An international supplier of industrial workstations and flexible production systems.	Engineering and design for custom-designed backplane assemblies and mod electronic enclosure systems.
Clients	Electronic, telecommunication and light assembly industries.	Various clients: e.g. electronic manufacturers.
Services	Individually tailored solutions for customers needs.	Tailored products and innovative solutions for customers' needs.
Organization	Expectations from various directions: continuous co-operation with clients, production and salesmen is needed.	Development and design team is constituted by three groups of people: mechanical and electronics designers and programmers.
Co-operation	Expectations from various directions: co-operation with clients, production and salesmen (see Koike 2003).	Mainly with clients and among three group of designers. Co-operative work by both users and designers (see Jaikumar & Bohn 1992).
Characteristics of the job	Work with special products for every customer's individual needs, usually with only little reference to past cases (see also Bødker & Grøenbæk 1998).	The problems are large in size and complex and never-ending by nature. Situations change and solutions are of short duration.

The group of designers studied in Industrial Workstations work as a team designing so called 'special products', which are modified versions of the company's standard range of products, tailored to meet individual customer's

needs. The group are led by team leaders who also have design responsibilities. The specific design tasks differ somewhat from one designer to another. For example, some of the experienced designers concentrate on product design leaving responsibilities such as setting prices, estimating costs and setting up the production control program to other designers. Those individuals have many years of experience and a holistic understanding of the product range. Some of the designers, on the other hand, are responsible for a more limited product range. The process of producing a single product includes tendering, predesigning, preparing illustrations for offers, estimating costs, creating new product names, production planning, production control, buying materials, subcontracting, composing and dispatching products. With both customers' needs and the assembly line as the point of departure they aim to design a product suited to its purpose. Co-operation between the various teams (such as production teams and sales teams) is flexible, because they are located in two buildings around the same courtyard.

The development and research team in Electronics Design mostly supplies products and services to the ITC industry. Thus, it functions as a subcontractor, e.g. to the mobile phone industry. During the data collection period the team was under constant re-organization. At the same time, however, it was led by the head of the team and one line manager who were responsible for all the on-going projects. The group was divided into three teams which were working within their own designated areas of responsibility; mechanical designers, electronics designers and software designers. In principle, however, all the designers were involved in almost every project, which is why, despite being split into three as separate areas, continuous co-operation between the teams was ultimately necessary in order to gain as holistic picture as possible of the various projects. The other units of the company, such as marketing, administration, testing, implementing and production were located in another city about 40 kilometres distant from the R & D team. For this reason, the testing of new products was laborious and the designers travelled frequently between these two locations. Continuous communication between the two locations was an absolute necessity. A small laboratory was located in the same office space with the R & D team, however, so that pilot testing and product preparation were possible even there.

The group or team level contexts, those concerning tasks as well as organizational contexts of practice and learning were presented above. In addition, other contexts are assumed to be important when investigating learning at work. For instance, Korhonen (2003) found in his recent study of adult learners' learning contexts in web-based studies that many overlapping and coexistent contexts are present in learning and that they have inevitable effects on how learners perceive their practice and attribute meaning to their own actions as individuals and as a group. Due to the situatedness of life in general and the practices of working life especially, it is not possible to investigate learning in the workplace, for instance, through one such context only. Instead, contexts are in a constant dialogue with each other. In web-based learning (see Korhonen 2003) such contexts as personal, communal and

organising contexts were found. Korhonen's categorization of learning contexts formed the basis for the categorization of contexts adapted for this study of design engineers' practice and learning, and is presented next.

First, designers' context of practice is assumed to include an *individual or personal context,* which involves perceptions of oneself as a worker, motivation to learn and develop prerequisites to participate in everyday practice, competence, and sense of meaningfulness of one's activity. Second, the *work task context* determines what the designer is currently doing and what demands and frameworks determine his or her activity. Third, the *team/group context* describes the human composition by which everyday job is accomplished at the interactional level. It helps workers to compare their personal experiences and perspectives and supports everyday practice. Fourth, the *collaborative network context* describes the various other bodies and partners outside the workplace who are needed to for one to perform one's job. Finally, the *organizational context* helps the worker to locate his or her practice and learning in the contexts of wider relations of production. In this study, work practices are in most cases related to the four first contexts described above, while the organizational context is only referred occasionally.

In general, by context we usually mean temporal and spatial environment and surrounding of the activities under study. The most relevant contexts may, however, be difficult to define beforehand. It should be noted at this point that in the precise research, contextual background information was limited to views gained during observation periods. This means that most of the interpretations are based on my findings after observing designers' interaction at the group and team levels, and they are focussed on the activities that took place in those situations. However, the information gained from the interviews has in some cases also widened the contextual understanding of the author. It may therefore be argued that, for instance, information about organizational structures and hierarchies at a more general level or teams' connections with business principles as a whole was not available or, perhaps was not even needed. This is because, in approaching work practices ethnographically, it should be remembered that the contexts of practice are not solely determined from outside (see e.g. ten Have & Psathas 1995). Instead, the relevant contexts for practices are constantly being constituted anew both by the participants and by the work task themselves. In other words, contexts can be seen as constructed in relation to practice (Jokinen, Juhila & Suoninen 2004.)

Hence all the contextual information given in this section is there to enable the reader to interpret the individual- and group-level learning found to be taking place in the two settings. Naturally, in order to obtain a wider picture of learning on in the organizational context, more information, for instance documents, would have been needed to interpret what the larger organizational practices are like. Altogether, a major problem for the researcher is how much contextual information is needed to understand, for instance, a story told by a designer. A related problem is how much context the researcher should provide the reader and how to be sure that instances of interviews or extracts from tape-recorded episodes are representative (see e.g. Cortazzi 2001).

In this study, various contexts described above, are seen quite static elements which can also usually be referred to places rather than time. Situations or situationally defined occurrences and practices, instead, are seen here more dynamic and more referred to processes taking place in time rather than in more static places.

5.3 Deriving the materials: observations and interviews

In this study, the purpose of the observations was to describe the work setting and context, the situations in which learning is assumed to take place, and how the people involved see their actions and those of others (Hammersley & Atkinson 1995; Denzin & Lincoln 1998). Everyday practices and situations and ways of dealing with them become more visible through observations. By contrast, the meanings attached to experiences in working contexts can only be obtained from interviews. The purpose of the interviews was, thus, to understand the subjects' actions by obtaining information about the meanings attributed to learning in the work setting (Kvale 1996). Consequently, the interview and field data were combined, to enable better sense to be made of the one through the other (Hammersley & Atkinson 1995; Silverman 1993.) Below, the practices of observations and interviews are described and discussed in more detail.

5.3.1 Observations and researcher's role

Collecting data by observing is the most typical and traditional way of obtaining material from the field in ethnography. For many ethnographers ethnography is not ethnography without living, participating and observing in the field (see e.g. Davies 1999; Fetterman 1998; Hammersley & Atkinson 1995; Silverman 2001.) In this study, however, observations and interviews are closely connected as methods of gathering information. But, whether we observe, interview or act otherwise in the setting, there are always challenges to be faced. One of those is the role of the researcher and other relations constructed and maintained in the field, such as how the researcher's role might have implications for both the data collection and its interpretation. In my case, especially, entering and observing in male-dominated settings may have particular implications. Hammersley and Atkinson (1995) suggest that women researchers may find themselves the object of "hustling" from male hosts or they may be adopted as a sort of mascot. Fortunately, nothing like this happened to me. Instead, I think that in some circumstances it was, in fact, easier to present myself as a socially acceptable incompetent in technical matters, especially in the early stages of fieldwork. Some of the male workers were even flattered when I repeatedly ask them to tell me more about the technical details of their work. In this way, I assume that I also expressed honest

interest in their work practices. Most of the time, however, I felt I was regarded with neutrally, as if I had belonged to the furniture, especially after a few week's observation. In general, I felt that it would not be very wise to see myself very different from the people I was observing. Instead, I tried to behave as an ordinary person living in the same town, speaking the same mother tongue, reading the same newspapers and watching same TV-programmes (e.g. ice-hockey games) as my participants did. Such shared activities may be an important point of departure from which intersubjectivity, common ground and mutual understanding may begin.

For this study the role of observations was two-fold. First they yielded valuable contextual information when entering the field and a foundation on which the interviews could be built. Second, the observational data which emerged was the focus of the subsequent ethnographic analysis. The empirical data for the study is based on field notes during my observations and taped recordings of everyday work situations, such as official and unofficial meetings as well as conversations and negotiations between employees concerning work practices in general and various problems which they were trying to solve. Everyday discussions, discussions over lunch, corridor talk as well as gossip provided me with much data and even with information which I would have not thought to ask them for otherwise. Often comments were made voluntarily providing a wider account than I would have asked for fear of being too intrusive.

Observations actually consist of a cluster of techniques, and the researcher chooses those that appear to be the most fruitful in the given situation (see Davies 1999, 71). In this study written field notes and tape recordings were the main data collection techniques used. In either company videotaping was not allowed. In Industrial Workstations I sat and listened to the everyday work talk of two younger designers in their office. Thus they were selected as "key informants" (see e.g Whyte 1984; Davies 1999; Hammersley & Atkinson 1995) after negotiations between the team leader and the researcher. These designers were responsible for a very limited range of products. In their case, the process of producing a single product consisted of various tasks, as described earlier, and required competencies across a wide area. The office inhabited by these designers was an ideal observation site because other designers in the team and the persons from the sales and production divisions, for instance, often visited or phoned to negotiate work practices. In addition to these shared problem-solving situations, phone calls and discussions, I was able to take part in and record regular team meetings, coffee breaks, lunches and other official development meetings.

In Electronics Design my observation site was also ideal, as it was in the middle of an open-plan office, where the whole team worked together. It was usually possible to place myself unobtrusively near a couple or small group of designers (mechanical, electronics or software) and listen to their interaction and discussions. In this company as well it was possible to observe various kinds of meetings and unofficial talk. The scope of observations was to have a hint what is going on in the setting to better understand the job of designers

and the kinds of participative activities which may take place during the actual work. Also how this participative action may be interpreted as learning was later being sharpened in the interviews and thus the preliminary analysis gained from observations were deepened.

Researcher's role and the procedure of gathering observation materials

As can be seen from the above, I was an observer in the most objective of the term; I adopted a complete observer role as distinct from that of a complete participant, for instance (Davies 1999, 72). My observer role was also affected by an educator. For instance, I was not able to take part in everyday design practices as these were out of my scope of expertise.

As Delamont (2004) argues, the term participant observation does not usually refer to real participation with the people under study, but interacting with them while making observations. This means that for me writing field notes was the most typical way of gathering material from the field (see Delamont 2004; Emerson, Fretz & Shaw 2001). Constant and systematic note-taking and writing, however, is exhausting work. For this reason I used a tape recorder whenever something interesting (discussions, working situations etc.) came up, as anything not recorded or written down is lost and cannot be returned to later. These recordings will be called "work talk" in this report. Observing was at its most fruitful when I found I could join field notes and tape recordings for the purpose of preliminary analysis and making initial interpretations (see Silverman 2001, 13). My initial interpretations could be thus compared, for instance, to the interview analysis. Furthermore, if my initial impressions were very vague, I could always ask workers to confirm my initial constructions. Very often, it was the various technical details that I wanted to know more about.

Field notes and preliminary jottings were primarily descriptive for me. Thus for the most part they were running descriptions of events, people, and things heard and overheard (Emerson et at. 2001; Whyte 1984, 84), especially as observing this kind of technical occupation was very unfamiliar for me. Of course, my field notes also included detailed accounts of my initial impressions, key events and incidents observed in the setting along with my personal reactions, what those in the setting treated as especially important, and any unusual events (Emerson et. al. 2001). Since the observation period cannot be free from preliminary analysis either, my field notes included analytical commentaries and a few theoretical notes as well. The possible preliminary categories we use as researchers will inevitably also be theoretically saturated, whether or not we realize it (Silverman 2001, 65). In general, I would argue that the field notes helped me to interpret the recorded "work talk" and vice versa. As the field notes included much descriptive and analytical material I could return to them later and revise them on the basis of preliminary analysis.

Given that both settings, and jobs done in them, were quite unfamiliar for me, I chose to write down everything possible in order to obtain as holistic picture as possible of the designers' work practices during the first weeks of

observation (Fetterman 1998, 35–39). This stage also included initial and unstructured interviews such as conversations, which helped me to draw a general picture of what was going on in the setting. After this initial observation period I could concentrate on (and possibly also tape) interesting details or creates preliminary hypotheses on the basis of literature or transcriptions of field notes (see Emerson et. al. 2001). The constant observation were quite exhausting and I tried to avoid stayed focussed by not staying in the setting for more than 4–5 hours daily. After each intensive observation period I usually withdrew to write the field notes down. The advantage of this was that the daily events were still fresh in my memory, and that often some initial interpretations emerged during these writing sessions. The next observation session may have thus started by asking about and seeking confirmation for various issues from designers and observing from new perspectives. It is possible, however, that many important findings may have been lost due to the limited numbers and short duration of observations over all.

As stated above, as an educator, I occasionally found myself wandering around in a strange technological world with its own vocabulary. This had implications as my role as an outsider observer may have had on the results, and on my interpretations made in the field. If, for instance, I had an engineering education, the organization of work, flow of design projects or the quality control system of the workplace as important areas of learning might have been construed quite differently. Instead, with my background in education I may have emphasized, alongside learning targets, learning processes as well as social relations and the essential role of emotions in learning in my interpretations.

Participation and disengagement from ethnographic research

When studying an unfamiliar setting, such as these two workplaces, the ethnographer may face a kind of a culture shock (Delamont 2004; Hammersley & Atkinson 1995). This was my experience at first, although after a while I begun to feel quite comfortable. Although entering and being in the field are seen as very important phases of fieldwork, the disengagement from the field is just as important. If one starts to feel too much at ease, the time has come to ask oneself if all the material needed has already been collected, and whether there is any point in remaining in the field or whether one has been too compliant (see e.g. Delamont 2004; Hammersley & Atkinson 1995). I reached this point after 5–6 week in the settings, after which I made the decision to start the interviews. I thus felt confident enough to seek the necessary contextual information at that stage.

5.3.2 Interviews

After the observations, the eighteen designers identified in table 2 were selected as interviewees. The selection of the interviewees was based on my judgement as a researcher as to how my knowledge would best develop. In Electronics

Design the selection of interviewees (n = 10) was practical. All the observed persons offered themselves as interviewees, and thus the selection was unproblematic (c.f. Hammersley & Atkinson 1995, 134–136). It even seemed to me that all of volunteers also self-evidently committed to the interviews, as they had already done in the case of the observations. Their agreeing thus may also have related to the fact that many of them were interested in the opportunity to talk proudly with the researcher about their own expertise and thus converse with someone who would listen to their views about learning and development at work with no strings attached (see also Hytönen 2002, 66).

As only two persons were primarily observed in Industrial Workstations, a further six designers were selected for the interviews as well. Thus eight persons altogether were interested in acting as voluntary interviewees in Industrial Workstations. The additional interviewees were the team leaders and designers of special products and product development teams. Thus they were the designers who most often co-operated with the two designers observed earlier. It is possible that more voluntary interviewees might have been found in Industrial Workstations, but neither more time nor other resources were available for interviewing in this phase of the study after the time-consuming observation period. Consequently, for this practical reason, the number of the interviewees was initially limited to eighteen cases in all.

As a method of enquiry within the ethnographic framework the interview is common and the most natural as the research questions themselves are often best approached by interviewing people. Where the target of research is to increase human understanding, questionnaires, for instance, are not enough alone (see e.g. Syrjälä, Ahonen, Syrjäläinen & Saari 1994, 86–88). In fact, as Silverman (2001) argues, "we are living in the interview society in which interviews seem central to making sense of our lives".

Ethnographic interviews differ from structured or direct interviews in that ethnographers do not usually decide beforehand the exact questions they want to ask and do not ask each interviewee exactly the same questions, although they usually enter interview situation with a list of issues to be covered (Hammersley & Atkinson 1995, 152–153). In these senses ethnographic interviews are closer in character to conversations than, for instance, survey interviews. However, they are never simply conversations, because the ethnographer has a research agenda and she must retain some control over the proceedings (see also Fetterman 1998; implicit agenda). Thus the interviews conducted in this study may be characterized as something between semi-structured and ethnographic interviews. This is because, on the other hand I knew quite a lot about the interviewees and their work contexts before the interviews, and on the other hand the place and time of the interviews were purposefully arranged even if the questions to be asked in interviews were not predefined nor exactly the same for each interviewee.

The interviews were started after the observations. This order may be explained by the fact that I had better sense of the contextual information that I found necessary at that time. It was also easier to build the themes for discussions on the basis of the background information gained. In addition, it

was possible to check matters which had remained obscured in the observation situation (for instance, technical or culture-related details) or to interpret what had occurred in certain working situations together with the interviewee. Thus, it was obviously easier for me to locate the interviews in their contexts (see Rapley 2004.)

Interviewing procedures

All the employees were interviewed individually for approximately one and a half to two and a half hours, usually in the interviewees' personal office or in a separate negotiation room. All the interviews were tape-recorded with the designers' informed consent. I had informed them that the purpose of the interview was to supplement the observations conducted earlier and to find out about their experiences and conceptions of learning at work. They were asked to answer the questions on the basis of their own experiences, and emphasized that there were no "right answers". Owing to the congenial atmosphere and rapport created during the observation period (see Hammersley & Atkinson 1995, 141), it was assumed that the interviewees would be inclined to be honest. Thus, a common interpretative space for the discussions was created (see Kvale 1996). Even though common themes and questions were used in all the interviews, they did not proceed in exactly the same manner. Rather, the situations could be described as conversations about working and learning in the workplace. Thus, every interview was unique and followed its own particular route. In most cases, I had a series of questions to ask the participant and would wait for the most appropriate time to ask them during the conversation (Fetterman 1998). The interview themes and more detailed questions are presented in appendix 1.

In order to be able to understand the ways designers work and how they used their technical vocabulary and effort was made to understand and use this vocabulary. While not understanding everything they were talking about, I also tried to be as natural and sensitive as possible (Davies 1999, 102–104; Fetterman 1998, 45–47). For example, the interviewees were not pressed, for example, to disclose anything unwillingly. It has been especially emphasized that ethnographic interviews are fields of common interpretation in which both the interviewee and the interviewer take part (Kvale 1996; Heyl 2001). Although it is usually reasonable to minimize the influence of the interviewer, it is misleading to believe that this is ever completely possible, however (e.g. Holstein & Gubrium 1995). Neutrality as such is thus not a purpose (see Kvale 1996, 157–159; 286–287). Instead, for instance, I noticed that by speaking openly and sometimes by feeling provoked to utter my own opinions, an interesting exchange of views and shared experiences on working and learning may begin (see Davies 1999, 96; Hammersley & Atkinson 1995, 152–155; Rapley 2004). Heyl (2001) has described such an approach as research collaboration between the researchers and the interviewee (see also Holstein & Gubrium 1995; Rapley 2004).

Since exact analytical tools were not prescribed when the interviews were started, I attempted to build the interview situations more along the lines of a discussion than a structured interview. Following the principles of the ethnographic interview, the interviewees were requested to talk about their experiences of work and learning, but not directly, for instance, to tell stories. This is constant with the phenomenographic interview approach because too many questions should not be made up beforehand, nor should too many details be determined in advance (Marton 1994). Rather, the point is to establish the phenomenon as experienced and to explore the different aspects of the experience jointly and as fully as possible. Consequently, I encouraged the interviewees to state concretely what they thought was important for their work and learning. Usually it was also possible to ask the subject to come up with instances of the phenomenon in question, such as examples of learning situations in which both interviewee and I, as an interviewer, had been present. A concrete case could often be found as a point of departure, and the researcher then asked the subject to reflect on the situation or problem and his way of dealing with it (see e.g. Polkinghorne 1995). The interviewees' stories, emerging from the interviews, are seen as giving a personal voice to learning through experience in natural contexts, i.e. in the situations in which these experiences arise (see May 2001; Riessman 1993). It is important to remember, however, that our activities are constructed by the organizational context in which we are practising. This suggests that our practice can also be changed by our narrative understanding (McEvan 1995). This is also why our experiences about practice and learning are in constant flux and constituted by how we perceive the various settings that surround us.

The themes for the interviews sprang both from the theoretical literature and previous studies in the area of workplace learning as well as from the initial hypothesis formed in the field. However, it can be seen from the jottings of my research diary that the practical importance of most themes ended on the list of interview themes have arisen from everyday observations. In other words, these themes were the ones which were hoped to be helpful to find out how workers would see their own action as learning at work. Since the phenomenon of learning was not expected simply to be outlined at once by the interviewees, I did not bring it up, as theme, right from the start of the interviews. Instead, I attempted to approach learning in a roundabout way with help of other themes, such as the competencies needed in one's job or the challenges faced at work, with the help of which interpretations concerning learning could emerge. This turning to the interviewees' everyday concepts of practice also helped them to say more about their learning. The themes taken up in the interviews were thus: tasks being currently worked on, the competencies needed in design work, challenging situations at work, the organisational atmosphere and culture of the workplace, and learning at work. The employees were asked questions such as: Tell me about your current job? What kinds of competencies are needed in order to meet the challenges of your everyday job? Where have they come from? How do you feel you learn at work? Describe a challenging or problematic situation at work? How did you

solve the problem? What did you learn? The full list of interview themes (and questions) is given in appendix 1.

In the beginning of observations in Electronics Design I also asked workers to write in a "learning dairy" anything they may notice regarding their learning in everyday practice at work. Though this experiment of an additional method of data collection failed as a whole due to designers' lack of time, a few of the younger designers did, however, write a couple of things down. Any such notes were discussed in the beginning of the interview. Although they were not very illuminating as such, they gave me valuable background information about how important everyday practical routines are for new-comers when they are getting to know the habits and practices of a new social community.

Although very essential and different data were collected in the two settings (see Hammersley & Atkinson 1995, 140), for instance from observations, it may nonetheless be asked, whether it would have been wise to have collected more information through more unofficial interviews during the observations. In addition, the interviewer must always remain aware of the likely effects of her questions on what is and what is not said by the informants. For instance, in this study, it seemed to be that some of the interviewees purposefully sought to avoid issues concerning problems and challenges faced at the organizational level or these were discussed in a very neutral tone and on a general level.

5.4 Mixing methods of qualitative analysis in ethnographic frame

In general, the main aim of ethnographic analysis is to interpret subjects' interpretations at a more general level (see e.g. Syrjälä et. al. 1994.) In this study, however, the role of ethnographic analysis is more one of connecting theoretical and empirical aspects since interpretations do not emerge so directly from the specific theoretical approach taken. Successful interpretation makes the obvious even more evident or reveals the concealed. Interpretations are usually narrative depictions of subjects' experiences and perceptions. In addition, interpretations can help in obtaining a clear picture of how different things are connected. It is also necessary to note that in ethnographic research data gathering and analysis cannot be distinguished as separate phases of the process, but are overlapping throughout. For instance, the analysis does not start only just after the data collection but already during it. This cannot help but influence interpretations, which usually begin when collecting the data. Thus initial interpretations are made long before the analytical phase of probe (see e.g. Hammersley & Atkinson 1995).

For the analysis all the interview tapes and tape-recorded work talk were transcribed verbatim while fieldnotes had been transcribed earlier during the observation period. One interview with one person produced approximately

twenty pages of text transcription. Thus altogether the interview data comprised approximately four hundred pages of transcription. The written up fieldnotes and tape-recordings together produced another 330 pages. All the transcription was done by the researcher. The manuscripts of articles to be published were sent to all the participants (where it was possible to find their current corresponding addresses) for their comments on the author's interpretations and to confirm the plausibility of the results. In the cases of the articles III and IV, however, only a few responses were received from the participants. Multiple methods of analysis were used, although the general outcome of these analyses conducted within an ethnographic frame was various categories or themes found in the observational and interview data. As explained by Seale (2004a), what most researchers actually do in qualitative analysis is thematic analysis regardless of the specific type of analysis. The entire analytical process was carried out by the author alone. The following sections describe more precisely how the various analyses were conducted.

5.4.1 Phenomenographic analysis as a basis for research process

The role of adapted phenomenographic analysis is argued first and foremost to be suitable for the overall purpose and the ethnographic framework of this research project precisely because it was the designers' own perceptions of learning in their everyday work practice which were being sought for (see article I). In addition, the justification for using phenomenographic analysis is that it is well suited to its purpose, i.e., it lays a foundation for the overall research process through which some of the results can then be more profoundly elaborated. The purpose of phenomenographic analysis is thus to outline qualitatively different ways in which people experience or think about various phenomena (Marton 1988), in this case, learning in the workplace. This analysis was based on interviews only. Phenomenography deals with relations between the individual and aspects of the world around him or her in the ways in which they appear to the individual. Phenomenography is thus not a question of making statements about the world as such, but about people's thoughts about it (Marton 1988.) Consequently, in the present study, phenomenographic analysis was utilised to find out what the engineers' initial conceptions of learning were preparatory to investigating some of them in greater depth at a later date.

It needs to be critically noticed here, however, that the model of phenomenographic analysis applied here is not the only or right one. During its 30 years history phenomenographic analysis has been applied in various ways, and it has recently moved on from being primarily a methodological tool to being a theoretical approach (see e.g. Hella 2003; Marton & Booth 1997; Marton & Pang 1999). In this study phenomenography has been applied as it was originally seen, i.e. as a method of analysis. This means that the meanings of engineers attribute to their learning at work have been constituted from the interviews, whereas, the structural relations between those meanings expressed

in categories of descriptions have not been elaborated. The latter is an important direction in the recent developments in phenomenography.

Although phenomenography shares certain basic research assumptions with ethnography and phenomenology (see Maso 2001), for instance, the importance of internal relations, experience, content and qualities, there are also differences. According to Marton (1988) these differences are not all that evident, and to the extent they exist, they are due to differences in interest rather than basic assumptions. Phenomenography has been criticized, for instance by ethnographers, for seeing categories of descriptions as results, as such categories cannot contain the richness, naturalness and context-boundness of description characteristic of ethnography. It is argued, however, that this criticism is avoided, in this study, by the further investigation of those categories which emerged as most important and interesting in the initial phenomenographic analysis.

In phenomenographic analysis, categories of description are seen as the main research outcome. The most essential, most distinctive and most structural aspects of the relation between the individual and the phenomenon originating from a contextual understanding are sought for. The adapted phenomenographic analysis reported here was carried out as described by Marton (e.g. 1988, 1994; Uljens 1989): First, utterances relating to the topic in hand, that is, how learning takes place at work, were extracted from the interviews. According to the principles of phenomenographic analysis, attention was then shifted from the individual subjects to the meanings embedded in the utterances, regardless of whether these meanings originated from the same individuals. Thus, the interviews were handled as a whole to extract "a pool of meanings" and read repeatedly. After the initial selection process they were more closely examined in order to assign utterances having a similar meaning into preliminary categories. After this, a more detailed analysis was carried out in terms of core meanings and borderline cases between categories. This analysis established the final descriptive categories, and in some cases subcategories. The entire analytical process was carried out by the author alone. To establish the reliability of the analysis all the interviewees were asked to reflect on the results and say whether the categories captured their understanding of how they perceive learning at work. This will be taken up in the discussion section of this report.

Some principles of the phenomenographic analysis were also applied in the sub study described in article V. In this study design engineers' and computer science students' experiences of learning at work were compared. The phenomenographic analysis adapted resulted in qualitative categories based on the description of learning in two different sets of interview data and two contexts of learning. The focus was on identifying similarities and differences. The analysis was conducted in collaboration with a co-author.

5.4.2 Narrative analysis as a part of ethnography

On the basis of the phenomenographic analysis the themes regarding the role of former work experiences (see article II) and the meaning of co-operation for learning in the workplace (see articles III and IV) were chosen for closer reinvestigation. In order to gain information about designers' perceptions of the role of experience in learning, I decided to conduct a narrative analysis. Experience has been assumed to be best approached by a method which allows the voice of the participants themselves to be heard and the meaning of experience to be shared (Cortazzi 2001). Thus it may be argued that people spontaneously tell stories to bind together significant events and important relationships in their lives (Cortazzi 2001; Lieblich, Tuval-Mashiach & Zilber 1998; Riessmann 1993.) In addition, by combining the content analysis and categorical content analysis (see Lieblich et. al. 1998) it was hoped to ensure that individuals' experiences were actually investigated in relation to their authentic contexts and that as holistic a picture as possible would be obtained. The narrative approach applied in this study could also be described as moving from a narrative to a more categorical analysis, which can also be described as a paradigmatic type of analysis (e.g. Polkinghorne 1995). Therefore, instead of seeking to operationalize the role of experience in learning at work too overly beforehand, the aim of the qualitative and data-driven analysis was to create a dialogue between the data and the interpretations of the researcher (see Silverman 2001).

The phenomenon of working and learning in everyday practice was seen by the designers as an integrated whole in which the role of experience was only one, though important, part of their learning (see also article I). In some places in their stories it was difficult to separate out the element of learning from the task itself, from the processes involved in doing the task, from the possibilities for learning and development, or from progress in the subject's career. It was the researcher's task to interpret the references to learning and development both from the interviews, seen as a whole, and from the core stories. By studying the sequence of stories in the interviews, and the thematic connections between them, it was possible to see how the designers linked significant events and important relationships concerning their job and learning. The analytical process proceeded from the larger contents of stories to a specific description of the learning categories or dimensions. The steps in the analysis are presented in figure 2.

The first step in the analysis was to read through all the 18 interviews to obtain a holistic picture of the interviewees' perceptions. On the basis of this holistic reading a thick description or a core story was created for every interview (see e.g. Bell 1988; May 2001). The work context, the task to be performed, the amount of experience and the subject's position in the organizational hierarchy, for instance, were included in the analysis. Thus, this version of the story resembled an enlargement of those parts of the interviews in which the designers disclosed their feelings and opinions concerning work and learning. The core stories about learning were rewritten by the author.

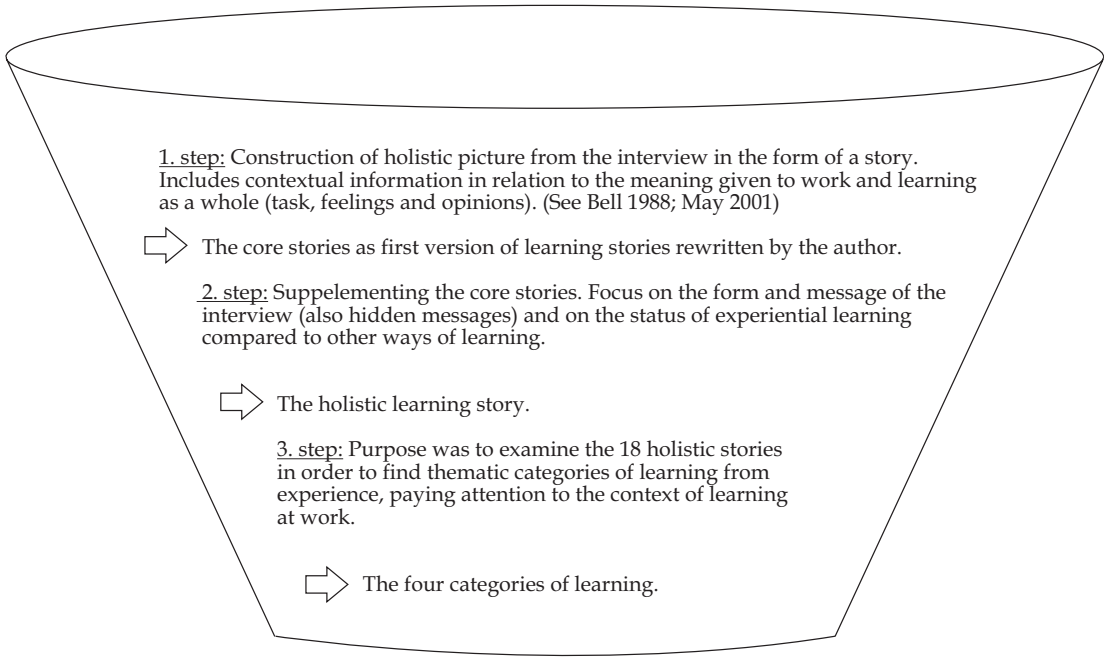

FIGURE 2 The steps of the narrative analysis

After creating the core stories the interviews were re-read and supplemented by searching for messages that might have remained hidden. Central themes emerging from the stories were also looked for. As a result more holistic learning stories were constructed. The focus of the analysis was on examining the status of learning through experience compared to other ways of learning in the workplace. The purpose of the final step was to examine the 18 holistic core stories in order to find thematic categories or dimensions of learning through experience. The outcome of this analysis was the identification of four main categories running through the designers' stories. Since features of all of the categories could be found in most of the stories, it was not possible to identify types or groups of stories which would have described individual designer's learning in only one way. Thus, it was not possible to state what percentage of the 18 interviews (or stories in this case) fell into a certain category of statements either. It was typical, however, that an individual story would emphasize one or two dimensions more than the others, which justifies labelling the categories dimensions of learning through experience.

The final categories were written with the focus on the designers' explanations and interpretations of how they see the meaning of experience for their learning and work, and what kinds of things are learned only through experience and why. In the interpretation process attention was paid to similarities which might be found in some or all of the stories but, more particularly, to differences as well as to specific tasks, position, age and other contextual issues which may have implications for the designers' conceptions and experiences. The added value obtained by using a narrative analysis instead of, for instance, simple categorisation of the answers was that it allowed

of the possibility to interpret every interview as a whole in its natural context. The names for these categories emerged from the analytical process. The author carried out all the analytical process alone.

5.4.3 Adapted ethnographic analyses

While the analytical choices of articles I, II and V were based on the interviews, articles III and IV were more heavily based on materials from the observation period, i.e. field notes and taped work talk. The aim of the ethnographic analysis conducted in these articles was to gain a deeper insight into what is learned and how through social communities and shared practices in the workplace. An additional aim was to capture negotiations and exchanges of views in the workplace in which conflicts and clashes may also occur. The purpose of the observations was thus to describe the contexts and the situations in which shared practice was produced and constituted in the workplace. The purpose was also to describe the situations in which learning is assumed to take place, and how the people involved see their actions and those of others (Hammersley & Atkinson 1995; Denzin & Lincoln 1998). The interaction situations of technical designers were essentially bounded up with the technical nature of their work itself. Hence a wider knowledge of cultural aspects of this job was necessary to understand this interaction (see ten Have & Psathas 1995). Article III is entirely based on ethnographic analysis and in article IV adapted membership categorization analysis (MCA) was combined with ethnographic analysis. Further, additional views on learning in two different work contexts were obtained and compared in article IV. The MCA will be described in more detail later in this chapter.

The findings concerning the features of learning in shared practices were described and interpreted with help of an extract (vignette) chosen, among many similar ones from the field notes, (see article III). This vignette shows concrete co-operation between a few employees from different sectors in process as well as very frequent and commonly used ways of negotiating for the best possible solutions to a problem. In addition, the extract includes many of those elements which could be interpreted as the most important mechanisms of producing and constituting shared practice and ways of learning through it. Additional extracts from taped "work talk" were also presented (see articles III and IV) to support the author's interpretations and help reader to evaluate the reliability of the interpretations (see Davies 1999). In article III the author carried out the entire analytical process alone, while in article IV it was conducted together with the co-author.

Ethnographic analysis has been described as one of constant interaction between concepts and data (Davies 1999), and as a continuous shift between background ideas and data (Silverman 2001) during which the interpretations emerging from the data may change and sharpen. In this study the transcription of the field notes and "work talk" (transcribed episodes of employees' conversations and meetings) were firstly read through in order to obtain a general picture of ordinary events in the settings and to find

introductory events and themes to return to later during the analysis (Brewer 2000). After the first reading of the data the most interesting episodes were re-visited in order to build up more general findings and formulate a preliminary hypothesis based on them. Ethnographic analysis is often described as a funnel-shaped process in which one proceeds from ordinarily very unclear foci of interest to more precise interpretations (Davies 1999; Hammersley & Atkinson 1995). As is the present case, it is usual in ethnographic analysis to search the data for general patterns or especially interesting events or situations, so called "key events" (Fetterman 1998). The purpose of the analysis thus was to find conversational episodes characteristic of ordinary work practice.

Membership categorization analysis

In article IV ethnographic and adapted membership categorization analysis (MCA) were combined in order to investigate what learning in the social communities of a workplace is like. The discussions and negotiations around work in the transcribed tape recordings, i.e. the speech produced by the participants, were analysed. MCA is an analytical device which has its origins in the ethnomethodological (see Heritage 1984) approach and has developed alongside conversation analysis. MCA aims to investigate how various categories of social phenomenon are thrown up in situated everyday negotiations between the interlocutors (see Hester & Eglin 1997a). The categories are thus condensed experiences and meanings bound to the institution in which the talk takes place. In other words, MCA directs attention to the locally used, invoked and organized presumed common-sense knowledge of social structures which members of the community are oriented to in the conduct of their everyday affairs. Membership categories are classifications or social types that may be used to describe persons (Hester & Eglin 1997a; Sacks 1992). Although the most usual targets of categorization are other members or persons in the target institution or organizations, practices and tasks may also be categorized (Järviluoma & Roivainen 1997). It can be argued, however, that tasks and the people who are practicing with them are connected and both are categorized at the same time.

Consequently, the ultimate aim of MCA is to make sense of the commonplace activities of ourselves and others. In categorizing talkers, we know who we mean when we talk about, for instance, "the guys upstairs" or "the lads on the production floor". The basic idea of the analysis is thus to break up and question the direct, situated and routine way of understanding an utterance and find other ways of interpreting it (Hester & Eglin 1997a; Sacks 1992, 236–251). In addition, it has been stressed (see Järviluoma & Roivainen 1997), firstly, that categorization is, in particular, a cultural resource which helps us to navigate in interaction situations, rather than a constant and cognitive self evident activity. Discussion must be interpreted in its context, otherwise it does not speak to us. Secondly, although categorizations are a routine action in social situations, we nevertheless are constantly negotiating

them. Thus they are not unchanging cultural codes but are always in flux according to the situation at hand (Järviluoma & Roivainen 1997.)

As part of the ethnomethodological tradition the adoption of MCA in this study can be explained by the resources it offers that buttress and deepen ethnographic analysis (see Pollner & Emerson 2001). Despite the criticism of ethnography by ethnomethodologists, their semantics also shows assimilation in that they share a methodological stance with the former as they both give primacy to explicating the competence or knowledge of members of a culture, the unstated assumptions which determine their interpretations of experience (Gumberz & Hymes 1972; cited in Hester & Eglin 1997a). In this study the MCA was used as a supplementary analytical device. It was not conducted, however, in an orthodox way but adopted as a complementary part of ethnographic frame of this study.

6 RESULTS – REDEFINING DESIGN ENGINEERS' LEARNING AT WORK

6.1 Summarising the research process and findings

This chapter summarises the main findings of the five articles produced to study design engineers' learning at work. On the basis of the results obtained during the research process and on the recent literature in the area, it also reflects on those results and redefines the phenomenon at hand. Table 4 presents a summary of the main findings of the articles.

First, the findings show the variety of conceptions of learning at work expressed by the engineers themselves. The findings of this first phase are presented in section 6.2. These results as well as authentic extracts from the interview data are described in more detail in article I. Second, the findings show what the roles of previous experience plays in learning in design work and what can be learned through one's own experience or that of others. These findings can be found in section 6.3, and a more detailed description of the results in article II. Third, a more objective picture of shared problem solving and shared work practices is given in section 6.4 and the results are presented in more detail in articles III and IV.

In addition to the approaches to designers' work and learning described above, the role of formal education and ways of integrating theoretical and practical knowing in designers' practice were investigated (see section 6.5). The results of this study are presented in article V in which also the experiences of workers and students are compared. Finally, section 6.6 suggests a redefinition of designers' learning at work on the basis of the empirical findings of this research and the literature in the field of workplace learning.

TABLE 4 Summary of the main findings

Conceptions of learning at work (article I)	The role of experiences for learning (article II)	Work and learning as shared practice (article III and IV)	Integration of theory and practice (article V)
1) Learning through doing the job 2) Learning through co-operation and interaction with colleagues 3) Learning through evaluating work experiences 4) Learning through taking over something new 5) Learning through formal education 6) Learning through extra work contexts.	1) The challenge of social interaction at work 2) Acquiring a holistic picture of work processes and projects 3) Learning from other peoples' experiences 4) Creating one's own view.	1) Maintenance of a sense of community and a good atmosphere 2) Practice is situated, interim and open-ended 3) Practice includes conflicts and contradictory aims 4) Practice involves the shared solving of work-related problems linked with networks outside workplace	A) Relationship between theory and practical action: - as a continuum - theoretical knowledge to be replaced by practical knowledge required at work - as complementary and often integrated B) Different contexts of education and work.

6.2 Design engineers' conceptions of learning at work

As described in chapter 4 the aim of the first phase of the research project was to obtain a general impression of designers' conceptions of learning in the workplace. At the same time the purpose of this initial phase was to build a base for the subsequent research questions and investigations. The conceptions of learning obtained from the phenomenographic analysis of the interviews and quotations from the data are presented in more detail in article I, pp. 140–147.

The multiform picture of learning at work given by the designers

The analyses of the 18 interviews yielded a great variety of themes on the topic of learning at work. The purpose was to report on the analysis of those descriptions which dealt with learning processes at work. This analysis thus focused on descriptions of "how" learning occurs at work, and not "what" is learned at work. Although "what" descriptions also occur in the six categories, they were included in these broader "how" categories. Thus they were analysed together. In the case of learning in a work context "how" and "what" questions are often inseparable. As a result of the phenomenographic analysis, six different categories of description were identified, some of which could be divided into subcategories: 1) Learning through doing the job itself, 2) Learning through co-operating and interacting with colleagues, 3) Learning through

evaluating work experiences, 4) Learning through taking over something new, 5) Learning through formal education and 6) Learning through extra-work contexts. The results are summarised in figure 3. The number of expressions in each category is indicated in parenthesis in each of the boxes.

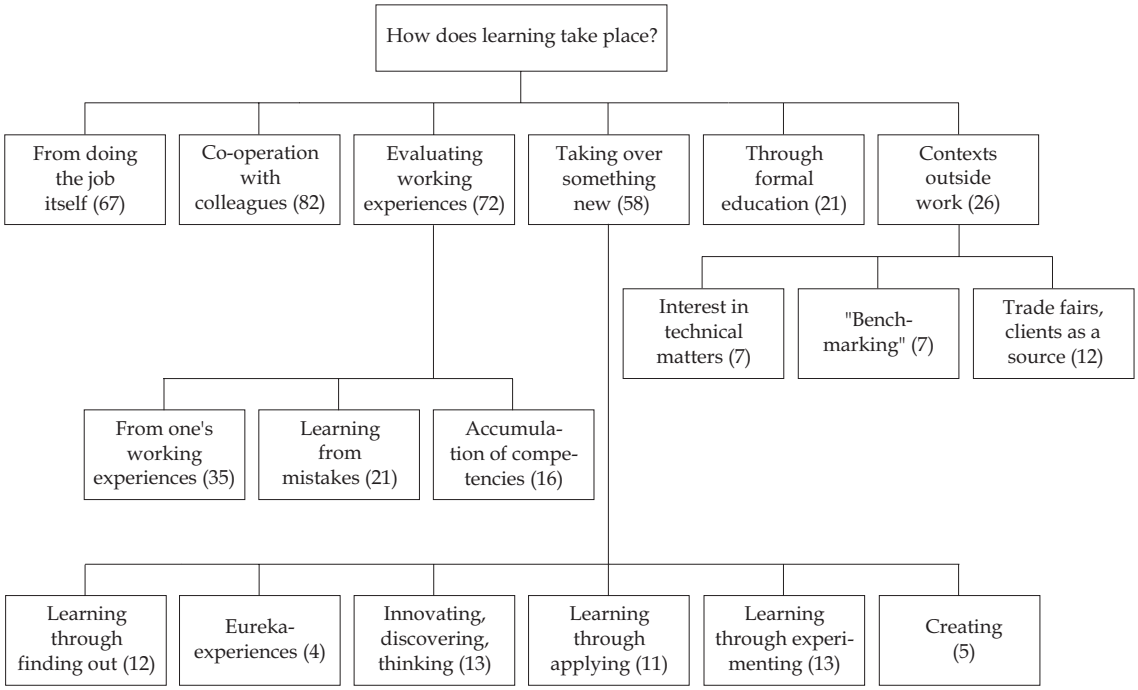

FIGURE 3 Categories of descriptions and the number of expressions in each category

The first category emphasized *the meaning of doing the actual job*. Expressions belonging to this general category were found in all the interviews. More specifically, learning was perceived as taking place in real everyday problem-solving situations. Problem-solving provides an opportunity to learn, for instance, about current procedures and tools. Learning by doing includes the various ways of understanding the situations one encounters at work and the frames determined by the task one is performing. This can be done by observing other people and colleagues at work. This category also includes understanding the nature of the competencies and knowledge needed to accomplish specific tasks and knowing of other employees who possess this knowledge. This conception of learning seemed to be very context-dependent, that is, only those things needed to perform the specific task were learned.

The second category, *learning through co-operation and interaction*, illuminates the importance of other people at work, and thus was the most usual way of describing learning at work. This category includes asking for advice, listening, having discussions, considering issues in teams and at meetings, consulting colleagues and learning from their experiences. Stress was laid on the importance of not being left to cope alone with ill-defined situations at work. Instead, it was always possible to ask other people for help. The

importance of negotiation and discussion arises out of the testing of one's own ideas and from the desire to choose the best possible solution from among the various options. To observe and listen to experienced workers was perceived as a very valuable way of learning.

The third category was termed as *Learning through evaluating work experiences.* This evaluative view of learning was also very commonly expressed. Three subcategories emerged: learning through one's own work experience, learning from mistakes, and learning through the accumulation of experiences and competencies. It was typical of this category that the resources for learning were located in past experience. Solutions and errors could be used to advantage in modelling new solutions. As a result of learning processes like these unconsciously modified competence or expertise could be accumulated, leading to greater knowledge about the job. The three subcategories show how previous experiences are important when harnessing them to new practices and situations, and how learning also has an emotional basis; for instance, negative feedback and mistakes are unpleasant.

The fourth category of description, l*earning through taking over something new,* was characterised by a forward orientation. The aim is to resolve whole new problems or tasks which are not necessarily solvable by reference to former cases or asking colleagues. Ways of resolving them are found in acquiring new information, considering various options, experimenting, developing fresh ideas, that is, acting creatively, and producing something new. The creative process may be emotionally demanding, usually takes time, and the worker's faith in eventually finding a solution may be weakened. Six different subcategories of this view also demonstrated that learning at work requires finding out, eureka-experiences, hard thinking and innovating as well as connecting theoretical and practical knowledge, experimenting and creating.

Learning through formal education. In this fifth category education was perceived as a foundation for learning at work. It was considered that without any technical education one cannot learn anything new at work. The ability to search for information in the right places and to know about basic methods and various tools was the outcome of formal education. It was worth noticing, however, that the more experienced the worker was, the more he reported the work itself to be an important or meaningful site of learning. The value of formal education seemed to fade with time.

Comments in the last category of description stressed that *learning also takes place in other contexts outside the workplace or school*. Interests," benchmarking", trade fairs, friends and clients were identified as contexts of learning outside the workplace. Three different subcategories illustrated how interest in technical matters may begin from childhood and grow as "a technical way of thinking", and how discussions and experiences across fields can be helpful in problem-solving.

Six different conceptions of learning at work emerged, ranging from learning through performing the job itself to learning with the help of contexts external to the workplace. Learning was most frequently described as the outcome of the evaluation of one's work experiences and of co-operation and

interaction with colleagues. The results also yielded a variety of other conceptions of learning in work contexts and thus give a multifaceted and complex picture of learning in the workplace, as perceived by the employees themselves. This does not imply, however, that some of the less frequent can be ignored; rather, they may all prove to be relevant dimensions of the learning phenomenon. In addition, while learning processes, according to the results, take place in the present, the resources for learning are located in past experiences, in previous solutions to problems or in mistakes made earlier in one's career. In some cases, however, an orientation to the future was also reported. This dimension involves experimentation; hard investigative work and creativity. On the basis of the results of this initial phase, learning as the construction of one's competencies through work experiences as well as seeing learning as a participative and collective process was chosen as the topic be explored more closely.

6.3 The role of former work experiences for designers' work and learning

On the basis of the conceptions of learning at work obtained from the phenomenographic analysis the role of experience for designers' work and learning seemed to be a theme that merited closer scrutiny. In order to investigate learning through experience and the meanings given to experience for learning in the workplace, narratives by practitioners in engineering and design were chosen as the focus of analysis. The specific research questions which guided the analysis were: 1) what is the role of experience in learning in the domain of industrial design work? 2) What is learned through experience? 3) Why is learning through experience an important way of learning in the domain of design work? This section summarises the themes or categories that emerged from the narrative core stories. The categories obtained from the analysis of the interview data are presented in more detail, including quotations from the data, in article II, pp. 111–127.

Learning through challenges in the work environment

The narrative analysis of the core stories yielded four categories concerning the role of former experiences. The first of them emphasises the *challenge of social interaction at work* and the decisive role of other people for work and learning. Many of the interviewees stated that the most challenging learning situations in their everyday practice involve interaction with each other, co-operation, functionality of the community of practice as a whole, or the ability to lead people equally. Co-operation and interaction are a means for learning but, at the same time, are also the focus of learning, and can take place only through working with other people. Furthermore, this dimension is characterised by

ambivalence in that other people are perceived both as a joy and also as a source of stress and oppression. They emphasised that these are the competencies which one cannot have formal education in, but which are acquired within the community in which they work. Consequently, learning within everyday social interaction was characterised by the important role of learning through practical experience. To cope with challenging situations involving other people designers have to go through 'hard knocks' on an everyday basis (see Snell 1992) and try to find ways of working with people. An additional feature belonging to this category and emerging from the stories is that the people working in a supervisory role seemed to understand exceptionally well the meaning of co-operation and interaction between themselves and those below them.

Another dimension that emerged from the core stories was the vital role of *acquiring a holistic picture of work processes and projects*. This kind of work process knowledge (see Boreham, Samurcay & Fisher 2002) is best obtained through everyday experience of the job. In both of the companies studied, the designers perceived that in their position between the clients' needs and the options on the production floor, a multi-directional viewpoint is needed (see also Rasmussen 2002). Knowledge and learning about work process was important for all the designers, the less experienced designers complaining of the lack of this knowledge while the experienced designers and supervisors said that they could not do their job without it. The latter group emphasised that they had to acquire a holistic view of their projects and products in order to deliver this knowledge to other designers. They also had to have an understanding of how these things are related to the world outside the workplace (for instance clients) and be capable of seeing things from many different perspectives.

Understanding the tasks or projects at hand as holistically as possible also functioned as a motivation for the designers. It is easier to get motivated and set to work knowing at least on the grand scale what one is doing, what one's part is in the larger entity, who the end user of the completed product is, or what final purpose the product is to serve. Through the accumulation of everyday experiences, asking appropriate questions, observing how things are done, and trusting the overall process, one learns to trust oneself. After seeing the general picture and how things usually go, it is also possible to cope well with more out-of-the ordinary tasks and projects. The designers said that it is experience alone which helps them to see the appropriate order in which to proceed in a task, to see to whom to give responsibility for different phases of the project, to recognise what kind of things must be taken into account at different stages of the process, what stages are likely to meet with problems and how to act with clients in uncertain situations. Taken together, designers saw it as important to recognise that the various frames of one's job resulted from the things described above and that these frames constitute part of one's professional competence.

The third category stressed *learning from other peoples' experiences*. Seeing the role of experience in designers' learning as important does not necessarily mean that all the workers should possess the same experience. The experiences or mistakes of other people, for instance, may be as important as their own.

Other sources of understanding and insights may be embedded in mistakes and jobs completed by colleagues, in products or drawings already made, in the knowledge obtained on the internet, at trade fairs and in trade union activities, this is, in knowledge located outside the workplace. Also clients were seen a very valuable source of learning; in fact they are, in a way, the initiators of innovations for designers. Another feature which emerged in the theme of benefiting from other's experiences is that the more responsibilities the worker has (team leaders) and the more experienced he is, the greater the importance of sources outside the workplace for his learning. And lastly, even though development work and design in both companies was largely characterised by creating and innovating novel products, many designers were of the opinion that the basis of design work, nonetheless, exists in what has already been done, seen, experienced or lived by somebody. At the very least someone else's views or understanding may function as an initiator for new applications or modifications and as such they can give a hint or direction as to where to find a new solution.

The fourth category emerging from the designers' core stories was by the importance of *creating one's own view*. Learning in the workplace was perceived as the accumulation of experiences which relate to one's outlook on life as a whole. The workplace is the real-life context where the worker can make his own contribution to meaningful and concrete tasks. According to many designers' stories, the capacity to create one's own view does not seem to be context-bound or connected to a specific work environment, but rather, is an all-inclusive attitude or property which grows towards expertise along with one's work experience and responsibilities. Learning was also described as constant growth and development, a phenomenon that occurs slowly in all phases of life. This aspect of learning as a property can also be investigated in relation to theoretical knowledge or learning in formal contexts. Professional expertise can be described, for instance, as a combination of practical experience and theoretical analysis, enabling one to form one's own view and gain a deeper understanding of one's work. Also, what one's interests are focused on and one's general attitude towards life play an important role in learning at work. For instance, the desire to be in the vanguard of technical progress and be able to develop new products of use to people at this very moment in the modern world boosts designers' learning.

On the basis of the narrative analysis of the holistic core stories learning from experience has been seen to play an essential part in both coping and learning with other people and benefiting from their experiences in the workplace, in understanding work processes holistically and in creating one's own way of thinking and viewing one's job and learning in it. The findings of this study show that the role of experience in workplace learning is related directly to other people in various ways and especially to how people co-operate. The role of experience in learning is also related to the work processes themselves and to the knowledge of how to acquire and control these processes as parts of a larger whole (sees also Boreham 2002). The processes of social interaction, for instance, using other's experiences to better understand the

current task or seeing other people as a means of learning, characterise the work of designers. In addition, a holistic understanding of processes is vital to survival in the changing world of work in general, and in this situation experienced workers have both important and specialist knowledge about work processes and the most holistic view of the job.

To sum up, in the designers' core stories a lot was also said about how the nature of experience affects learning in practice. As a result of learning from experience, various kinds of know-how and gut feelings may be acquired, accumulated and later applied in new situations. In the designers' learning stories experience was also described in a broader way, as life experience, which has accumulated in the course of time. This form of experience was also termed as wisdom or a holistic understanding of life in general (how to live and work with people) and as one's own way of comprehending and interpreting one's working practices. Another feature mentioned by supervisors is the central role played by external sources of learning. Even if these workers were experienced and had built their own ways of seeing things, the creative and innovative nature of design work also involves searching for different models and procedures from outside one's own workplace.

6.4 Engineers learn through shared problem solving and shared practice

While the previously presented analysis of designers' conceptions of learning at work and their perceptions of the role of experience for their work and learning concentrated on subjective aspects of learning, the present study of the interactive, communal and shared nature of work practices approaches workplace learning from a more "objective" point of view. The findings are based on ethnographic and adapted ethnomethodological analyses of field observations and recorded "work talk" obtained from the two work settings. This section summarises the features which characterize social situations and collaboration as shared learning in the two workplaces. The characteristics of shared practices and learning at work are presented in more detail, including quotations from the data, in articles III and IV. Article IV is co-authored.

Social communities and shared practices as spaces for learning at work

On the basis of the findings obtained from the ethnographic and ethnomethodological analysis, it can be argued that there is a need for practice to be shared by workers from various teams, groups and networks, even on occasion from outside the workplace. Thus from the practitioners' point of view, it does not make sense to separate working, learning and the social life of the workplace from each other. Instead, in order to survive in everyday practice, various components of that practice must be treated together. On this

view of the practice of designers, the ethnographic analysis described earlier yielded *four thematic findings* concerning the shared nature of designers' learning at work:

- Maintenance of a sense of community and good atmosphere were important components of work processes and learning in them.
- Practice is situated, interim and open-ended.
- Practice includes conflicts and contradictory aims.
- Practice involves the shared solving of work-related problems linked with various networks outside the team and workplace.

Below, each of these findings will be further elaborated.

Work towards the maintenance of a sense of community and a cosy atmosphere

At first sight, the designers' everyday work seemed to proceed smoothly and cosily without any major problems coming between them. On closer examination, however, the efforts made to sustain this sense of smooth interaction were quite considerable. The collaborative nature of designers work forces them to adjust to different combinations of people and teams, forcing them in turn to learn and develop ways of maintaining a positive spirit and shared understanding (see Sharrock & Button 1997) in order to achieve their collaborative aims. Thus despite the clear indication that the designers primarily wanted to get the job done in their own way and thus save face, efforts to sustain a positive atmosphere at work were made whenever possible. This was achieved by joking with colleagues and labelling (team) participants not physically present (see Sacks 1992). In addition to the situations described above, various kinds of stories are told, first to teach inexperienced workers technical details relating to different tasks and, second, to ensure that a positive atmosphere for social interaction is maintained (see also Housley 2000; Orr 1996). Telling stories about others' doings and mistakes, is a way of avoiding designers make a colleague responsible for possible mistakes they themselves have made or might make, while alluding to these possibilities made by someone else. By telling stories designers also socialize novices into the company's ways of doing things, and newcomers, for their part, learn to anticipate problematic situations involving different tasks, departments and colleagues.

The knowledge which structures the activities of workers, such as ways of maintaining a sense of community, is knowledge about the qualities of the people (colleagues and other people outside the workplace) targeted or involved in the activity. Apart from people, this knowledge also concerned work tasks. Such knowledge about the qualities of people or tasks is called social *categorisation*. Categories represent crystallised condensations of experiences and meanings (Heritage 1984). Shared cultural knowledge at the workplace includes, among other things, associating such categories as ”young people”, ”customers”, ”the management” or ”production people” repeatedly

with certain characteristics that need not, as a rule, be spelled out during interaction. Instead, everyone knows what such categories of people mean about when they are mentioned (see Sacks 1992, 40–41).

The findings from work talk show how everyday work in the contemporary workplace, in the present case engineering and design work, is characterized by sharing. Thus from the learning point of view, in addition to the question of how to get the job done, it is also important to ask with whom it would best be done in order to progress in the future as well (see e.g. Wenger 2003). Joking about and labelling (see e.g. Sacks 1992) of other colleagues would appear to be a common practice in workplaces. This is why learning to know different people and their ways of doing things is essential in acquiring knowledge, broadly at least, about what kind of solutions and agreements would be most appropriate in a given situation. Consequently, social categorisation is one example of an activity where each worker's identity and status within the work community is constructed and defined. Categorisation enables workers to find out how they are rated in their work environment.

Practice is situated, interim and open-ended

Another thematic finding, however, shows that *shared practices and the relations featured in them are not stable*. Instead, they must be, and are continuously created anew. The problems and conflicts encountered in shared practice, for instance, are often worked out and resolved in action or through social interaction rather than through analytical problem solving. Goals and plans are redefined and modified in response to changing contextual conditions (see e.g. Suchman 1987). Thus human action is seen not as determined by preconceived goals and plans, but as continuously evolving through the process of mutual adaptation between the actor and a changing environment (Ellström, Ekholm & Ellström 1998, 5).

Solutions are also situational and open-ended in a sense that they are negotiated and created anew on each separate occasion. Even issues taken up for discussion are negotiated and interpreted as problems that concern the team. Very often the problem-solving process seemed to remain unfinished as well. Such interim solutions have, however, a clear function in sustaining the sense of community in the team. Solutions indicate to employees that everything possible has been done to solve the problem and they can get on with their work. A solution of a kind has thus been reached even though it does not seem like one (see ten Have & Psathas 1995). Consequently, a conflict or problem (the processing of which has remained unfinished and without a resolution) may also be seen, where it does not constitute a threat to the work of the team, as an essential recourse for analyse and learning as part of shared practice.

As practice and problem solving are situational and temporary, it is reasonable to conclude that practice involves continuous learning across various domains in the workplace. These are the domains of social relations, the technical demands of one's job, and clients' needs. Since change seems to be a

ubiquitous element of practice (which is constituted collectively), it is important to note that responses to this constant change can also be shared by negotiation and reconciliation. In such situations, one learns that for every problem a suitable solution must be found. What is learned from this situated, open-ended, and dynamic practice is that one must learn to trust the expertise of the team, the work done by others and the fact that colleagues will usually help when asked. Also, appropriate ways of doing one's job, suited to this working context, will be learned.

The discourses of practice include controversies and disagreement

Even though most of the time work was carried on without major disagreements and with one voice, the present empirical data also featured conflicting aims and views. Most episodes included *conflictual talk related to disagreements within the team*, such as where a team member had neglected to perform a task despite having promised to do so. From this it follows, according to the designers, that practices already agreed upon must all too often be negotiated again. The work cycle is very rapid and neglected matters mean adding to an already high burden. Other divisive topics were lack of time and other resources, as well as the meshing of practices between the production floor and design department, or between other teams and team members. In some cases, however, conflict in the team concerned external matters such as neglectful or odd practices on the part of clients, partners or suppliers. The most usual disagreements concerned the best solutions to problems or the ease of cooperation in general. In cases where the focus of a problematic situation is outside the team, the team members find it easier to search for resolution together than in situations where they have to voice disagreement within the team.

The conflicting nature of practice may also manifest itself as a conflict between objective and experienced practice. Consequently, examples of situations in which organizational principles or official viewpoints differed substantially from the ways that things were actually done in practice were most common (see Sharrock & Button 1997). Differences between the views which emerged from the interviews with the designers and from the observation data were thus compared with the organizational rhetoric. These differences indicated that the idealistic aims declared in the official organizational discourse often appeared, to the designers, to be problematic and the cause of more dissension in the team than a set of ordering principles. On the basis of the examples of conflict between the official organizational rhetoric and the practice (see article III), it might be useful to consider how this "double reality" influences learning in the workplace. It may be difficult for workers and for newcomers especially, to learn the various conventions governing reality inside the team and the kinds of conflicts and problems that are situationally interpreted as problematic.

Consequently, it can be assumed that people learn and act in a way that allows them both to do their job and have an opportunity to attain their own

goals as individual workers. However, despite the disagreements and conflicts which characterized their everyday practice, processing and solving problematic situations seemed to bring the designers closer to each other. Problem solving processes as such may also improve the atmosphere in the team, especially when team members can respond as a group to practices external to the team or organization. As has been pointed out before, these factors seem to have a compensatory effect on a team's inner disagreements.

Practice involves the shared solving of work-related problems linked with various networks outside the team and workplace

The results imply that in order to accomplish everyday practice, designers' work in reality often involves, in addition to the closer social community and team described above, collaboration with various groupings and networks outside the workplace. In technical design these, networks comprise, in addition to the design team, the firm's clients and those workers who end up manufacturing the final product. Engineers doing industrial design work reported continually coming up against problem situations called for a quick resolution. Such situations often arose because a client's wishes and demands were impossible to meet as they stood. Accordingly, as the engineers described it, their work meant continual negotiations with the customer about their requirements and how these could be satisfied (see also Gripenberg 2004). Thus, for design engineers problem-solving is often about finding a compromise between the client's wishes and the feasibility of realising them. Solving problems of this kind may depend on the resources available, such as whether the manufacturing division is capable of fabricating such products in the first place.

Designers also stressed that the successful completion of a task depends very much on having as comprehensive a grasp of the relevant work processes as possible. Such work process knowledge (see Boreham 2002) is acquired and accumulated among other things through experience gained as one does one's day-to-day job. Thus, the engineers reported that it is their personal experiences and experiences shared with their colleagues that help them to understand what might be the most appropriate way to organise the various stages involved in performing a given task, who should be given responsibility for each subprocess, what factors should be taken into account at different stages, which stages are likely to present difficulties, and how one should behave when interacting with customers in problematic and unsettled situations.

Further, when first getting to grips with a new problem, the design engineers reported that it was vitally important to be able to acquire an overall grasp of the assignment or problem at hand. Another typical aspect of the designers' work seemed to be that the different work processes need constantly to be adjusted according to those involved, that is, they were obliged to consider as a team how to implement processes as smoothly as possible from the perspective of all parties and how to carry the work out in the most purposeful and economical manner. Thus, while learning has often been linked

with problem-solving (e.g. Bereiter & Scardamalia 1993), the findings from this study support the view that instead of being based on the application of a battery of general skills, problem-solving depends on operating within the parameters of a given situation and practices. The different alternative solutions to a problem arise from the features defining and the resources at hand in the specific situation and context. Moreover, problems in design work are typically unclear and they are often impossible to anticipate; and again, typically, those involved do not always agree on their nature or on what alternative solutions are available. Instead, they may rather be described as a collection of problems which can only have interim solutions.

6.5 Comparing designers' learning in formal and informal contexts

So far the results have illustrated the importance of experience and shared practices for designers' learning at work. The final approach to workplace learning was to study the role of formal learning (connection between theory and practice) for these employees and to examine work practices and school as different contexts for their learning. The experiences of students and employees also were compared, but this section focuses on the designers' perceptions. It also summarises the results of the analysis of the interviews, especially the employees' reflections on the role of formal contexts and theory for their learning. The outcome of the phenomenographic analysis adapted in this study was a group of different themes describing employees' experiences of school and theory in relation to their practice, and of school and work as different learning contexts. For a more detailed presentation of the results and illustrations of the themes see article V, p. 338–344. The article was co-authored.

Work-based learning and school-based learning: perceptions of designers

The analysis based on the interview materials revealed that the employees placed a great value on work-based learning, but varied more in their opinions about the value of school learning. Some of the designers emphasized the importance of work-based learning as against learning at school. They felt that the source of the competence they need to cope with their work is, in fact, mainly learned on the job. Other designers found formal education to be an important source of their competence, by providing them with basic knowledge of the area of expertise in which they are working. However, they also felt that this knowledge is eventually difficult to explicate in relation to practice. The interviews also revealed that people with long work experience found it particularly difficult to analyse the role of school learning in relation to practical action. To conclude, the perceived importance of the content of an employee's professional training in relation to their current work tasks seemed to wane in

direct proportion to the length of the time that had elapsed since they had completed their formal education.

The analysis yielded three ways of seeing the relation between the designers' perceptions of theory and their perceptions of practice in work and learning.

- The relationship between theoretical knowledge and the practical competence acquired on the job is a continuum.
- Theoretical knowledge acquired in formal education is replaced by new practical knowledge required at work.
- Theory and practice are complementary and often integrated components of competence.

Theory and practice as a continuum. Seeing theoretical knowledge and the practical competence acquired at work as a continuum means that theoretical knowledge (such as mathematical knowledge, familiarity with materials and familiarity with various tools, such as software, or with basic technical assumptions current in the field) is perceived as a foundation for the things that one learns on the job and for work-related activity. On this view one is aware of the distinction between knowledge gained at school and knowledge accumulated at work, but at the same time one recognises both as necessary preconditions of the successful performance of one's job. Furthermore, the designers saw it as a notable aspect of basic education that one learns about many of the tools, for example, during one's formal training, but that it is only at work that one learns to use them. Thus, formal education provides the grounding, but at work one must continue to learn so as to acquire the additional knowledge and skills needed to perform specific tasks.

Theory replaced by practice. In the conceptions belonging to this category a continuous process was assumed by which knowledge obsolete in terms of the competence that one needs to function in one's job – often knowledge formally acquired – is replaced by new knowledge learned on the job. Knowledge replacement was seen as a typical feature of technical product development, where the turnover of knowledge is rapid.

Theory and practice as integrated. Theoretical knowledge and operating in practical environments were also described as aspects of a single broad competence where theory and practice support and fuse with each other. Many designers emphasised that from the perspective of competence or the successful performance of one's job, theoretical and practical knowledge should not be considered separate; instead, together they make up competence as a comprehensive phenomenon. As these interviewees see it, theory and practice support each other in a way that includes an understanding of the rationale according to which a particular task should be carried out and of the requirements of the background elements of the relevant solutions, which in turn leads to an understanding of the boundary conditions of the given task. Moreover, some designers described the theoretical knowledge acquired at school and work activity as an integrated relationship that enabled them to gain

a personal vision. This happens, for example, when employees who re-enter education after several years spent in working life see the relationship between practice and theoretical knowledge in new terms. One is able to be more critical of both theoretic details and of work practice, thereby learning to understand them better.

The designers perceived the *contexts of learning* in education and at work as different as well. This means that it depends on the particular work context how far and in what ways it is possible to exploit at work knowledge and skills learned in education. On the basis of interviewees' perceptions it may be assumed that the value of the kind of conceptual understanding provided by formal education is difficult to discover or become aware of. Problems seemed to be caused, for instance, by the fact that work and learning in working life on the one hand and school-based learning on the other differ in their aims. Work and learning at work draw their deepest motivation from "an authentic, concrete or real aim that the work activity is intended to achieve". In working life such an aim is easy to picture, while merely studying for an exam is not seen as enough of a challenge to taking learning seriously. Many of the designers felt that at work one learns to do things, cope with the tasks one is given on time, while at school one learns to be passive. Such perceptions may be seen as a consequence of the fact that the designers probably described the school contexts they had personally experienced, in some cases several decades ago. In addition, of course, statements of this kind may also refer to contemporary educational contexts which have not been able to rise to the challenge of new learning environments in the education of engineers.

6.6 Individual experiences and shared practices of learning at work connected? – Redefining design engineers' learning at work

The aim of the present research has been to describe and understand design engineers' learning in the workplace. The following section is an attempt to draw conclusions from the results. They are, however, to be read as suggestions and ideas that have emerged from the analysis. The purpose is to redefine designers' learning in the workplace by giving a description of the features which seem to characterise designers' practice and learning in it. Therefore the purpose is not to offer an extensive model or theory of workplace learning, which may in itself be an impossible task (see Beckett & Hager 2002). Consequently, the findings presented above imply that work practices and learning should be seen as constantly in a process of change and being constituted anew by the work activity itself, workers' experiences and tasks, work contexts and the community, and social interaction. Though the findings have been obtained from different analyses and phases of the research process, they nonetheless seem to show the parallel and overlapping ideas which

characterise designers' learning in the workplace and which it may be suggested characterise their learning at work.

In the following, central themes or ideas in redefining designers' practice and learning are addressed:

1) design practice as learning in itself,
2) the relation between formal and practical knowledge in designers' learning at work,
3) the essential role of previous experience in learning in design work, and
4) design practices are situated, shared, networked and contextualized.

6.6.1 Praising designers' messy practice

At first glance, the research results seem to indicate that learning at work is so multidimensional as to be almost too impossible to approach and synthesize conceptually. Learning is involved in all the various events and processes taking place in the work context. This is evident, for instance, in that the most important factor in learning in the workplace in the designers' conceptions seems to be work itself. Typically workers experience difficulty in separating learning and work from each other, given that the ultimate purpose of work is to accomplish given tasks, rather than to learn per se (see Beckett & Hager 2002; Darrah 1996; Lave 1993). The processes of thinking, acting and learning at work are argued to be coincidental at one and the same time (see e.g. Billett & Somerville 2004).

Thus, conceptions of learning through doing the job itself characterise work practices in many ways. Engagement in workplace activities is more than just completing the work tasks assigned. The messy nature of design work has been noticed before in criticisms, for instance, of the idealistic picture often given of design following linear procedures or design as a cognitive problem-solving process only (e.g. Bucciarelli 1994, 2003; Henderson 1999; Sharrock & Button 1997; Rasmussen 2002; Schön 1987). Design tasks are difficult to fully disaggregate, break up or reduce to subtasks that can be independently pursued (Bucciarelli 2003). It is thus typical of design practice that the problems to be solved are not always visible during the each phases of the process itself, but often become so as a project nears completion (e.g. Schön 1987). This is a feature of design work which it is not possible to anticipate but which it is possible to learn to live along with various ambivalences and constraints of work (Sharrock & Button 1997; Wagner 1997).

Nor are problem-solving strategies unusual in design work. This has also been noticed in various occupations, as shown, for example, by Middleton (2002). Rather such strategies are context-bound and often based on pure trial and error, if assuming it is even possible to outline the actual problem. It has also been stated that expert designers are apt to be rather solution-focused than problem-focused (see Cross 2004). This was also found in the present study, in the designers' opinion the most essential purpose of work is to "get the things

done". The main aim of practice, thus, is to get the job done, not spend too long trying to define what the actual problem is.

Problematic situations at work do not come with ready-made neat solutions. Instead, very often the challenge is first to work out what the problem is, since problems do not simply present themselves to practitioners. As Beckett and Hager (2002) have put it, a major role of practitioners is to identify what the problems are in a given set of circumstances. Thus, it is typical in design work, and presumably for many other occupations as well, that problem situations in practice are usually not clearly outlined, defined beforehand, stable and always the same, but subject to change, interim and under constant renegotiation (see also article III). Not only are workplace situations in constant flux but so also are the employees that are involved in these situations, as has also been seen shown in this study. Consequently, from the design practice point of view, it is of little value to talk about designer's work as consisting solely of linear problem-solving, because it is not possible to reduce it to this single type of workplace learning.

What also supports criticisms of the design process as solely problem-solving emerged from the designers' stories in how their descriptions of doing the job itself as both a challenge and a site of learning. Acquiring as holistic a picture as possible of work processes and projects was perceived to have a vital role for designers' learning. In addition to the nature of design work, another important messy feature of design practice is that it is highly visual and creative (Henderson 1999; Kolehmainen 2001; Rasmussen 2002), learning taking place through the process of taking over something totally new. It could even be suggested that creative work, research, art and design usually involve learning as an essential element. The research process is obviously a learning process for the researcher. This in turn presupposes a motivation to meet new challenges.

6.6.2 The relation between formal and practical knowledge in designers' learning at work

In line with the previous notion of the importance of learning through doing the job itself is the relation between theoretical knowledge and the practical doing of the job, as experienced by designers. The findings of the present study seem to indicate that, from the designers' point of view, the separation of theory and practice is not necessary in everyday practice. Theory and practice were rather seen as an integrated and fused whole which it is difficult to disentangle into separate factors of learning or practice. This is seen in what the designers said about role of theory and formal learning played in their learning at work. Theoretical knowledge was most usually perceived as a necessary foundation or base for the practical competence accumulated during one's career and which is later integrated in the practical doing of the job.

In such a rapidly changing domain like technical design, theoretical knowledge obtained from vocational or professional education may also be perceived as replaced by or fused with new knowledge learned on the job. In general, the role of employees' professional training in relation to their current

work tasks seemed to wane in direct proportion to the length of time that had passed since they had completed their formal education (see also Beckett & Hager 2002). This may be argued to be natural for two reasons. First, the education of designers and engineers is becoming out-dated. And second, designers have obtained more experience along the way, and thus have learned through work.

The designers' experiences showed, however, that learning in practice is constituted more as processes in which it is difficult to separate theoretical and practical aspects from each other. Instead, in practice there are no right or wrong solutions to different situations, only better or worse options suited to specific purposes (see Kolehmainen 2004; Rahikainen 2002). Furthermore, as designers themselves described it, theoretical knowledge or things learned at school are an essential part of their competence as a whole and help them to manage both their routine and specific working tasks. Thus the role of theory as an inseparable element of practice should not be underestimated nor overemphasised in order to understand the learning that takes place in the design field or in work contexts in general. Therefore practice is not the application of theory but has an important and unique place when attempting to understand learning at work. Or as Barnes (2001) states; "the theory should be treated as involving thought and action together, and in so far as this is the case, embodied theory, as it were, is a part of practice itself".

6.6.3 The essential role of previous experience in learning in design work

In examining the role of experience many overlapping ideas and themes emerged. One example of those overlapping ideas is that experience functions both as means for learning and as the content of learning. In addition, in order to cope with different people and social relations, experience has an important role as it also has when trying to figure out work processes as a whole and better analyse design practices. Designers tended to perceive that even though development work and design is largely characterised by creating and innovating, the foundations of design work exist in what has been experienced before, in one way or another.

Agency emerging from individual experience was denoted in the present study in the important role attributed to experience in seeing oneself as a part of the working community and in building a picture of oneself as a designer. Functional social relations also played a key role in the building of individual agency. Everyday practices and interaction between employees thus enable the individual worker to take his bearings comparing it with his way of doing things with the perceptions of others. Labelling and categorization through social interaction are examples of attempts to fit an individual designer's view to the work context as a whole. This meant for many designers, especially novices, a process of hard concentration on how to work with different people. More experienced designers, in turn, were more sensitive about the meaning of co-operation and interaction between them and the designers under them. For some supervisors, for instance, the most radical learning experiences were not

in fact connected to technical tasks but to those involving other people. The same has also been shown in Darrah's (1996) study in a computer manufacturing company, where supervisors saw their main challenge to be in building up the self confidence of their subordinates (Darrah 1996, 130).

In any case, learning to know others and identify oneself within the larger context of work carried an emotional load which is a frequently overlooked aspect of learning from experience (see Eraut 2004). Joking was one way of dealing with situations which otherwise would have resulted in open conflict. Similar strategies for the construction of workers' subjectivity were found in Somerville's (2002) study of coal miners (see Billett & Somerville 2004). Consequently, social categorisation is one example of an activity in which each worker's identity and status within the work community is constructed and defined. Such categorisation may be seen as part of broader identity construction which enables workers to find out how they are rated in their work environment (Brown & Duguid 2001; Wenger 1998, 146–153).

The accumulation of experiences was also related to a designer's outlook on life as a whole. The capacity to create one's personal view (see also Paloniemi 2004) is connected not only with the specific work context but more broadly with other areas of life, such as perspectives obtained from friends and from technical hobbies or experiences of relations outside work. The creation of personal way of seeing things also relates to another observation by Eraut (2004). Namely, when referring to an experience, we are generally thinking about a single incident, but when we are talking about what we have learned from experience in general, and in the sense workers usually seem to use this expression, we are probably referring to our accumulated learning from whole series of episodes. Such a personal view was also found among outstanding designers in the fields of engineering and product design in the study by Cross (2004). In Cross's study problem spaces of design practices were seen to be constructed on the basis of the designers' personal perspectives, and creative solutions seemed to arise especially when there was a conflict to be resolved between the designer's own high-level problem goals and the criteria for an acceptable solution established by client or other requirements. Cross thus concludes that outstanding design expertise is fuelled by personal commitment.

Consequently, as has been argued by Billett (2004b), for instance, work contexts and various work situations do not appear as same for every worker, but their life experience and perceptions, skills and competencies accumulated along the way from various contexts also are brought to bear on their views of understanding and acting in everyday practice (see also Hodkinson et. al. 2004). Workers bring their prior knowledge, skills and views with them, which in turn, can contribute to their future work and learning, particularly when entering a new workplace. As Billett states, it therefore seems salient to acknowledge the contributions of the social suggestion not only through the immediate experience of workplace, but also the social and cultural suggestion encountered and engaged with and which mediates individuals' development throughout their life histories or ontogenies (see also Billett 2003a; the example of hairdressers). This kind of historical development is reciprocally socially and

individually mediated, and is probably directed towards the maintenance of individual as well as social goals in practice.

6.6.4 Design practices analysed as situated, shared, networked and contextualized

It has been argued until relatively recently that technical product design and development work is first and foremost individual work the aim of which is to solve ill-defined and open-ended problems. As shown in the findings of this study and in the recent literature on design work, however, contemporary design would better be characterised as social and collaborative and a team effort involving various networked partners (such as production, marketing, sales and customers) (see e.g. Baird et. al. 2000; Brown & Duguid 1992; Kolehmainen 2001; Petre 2004; Rahikainen 2002; Rasmussen 2002; Sharrock & Button 1997). As the designers emphasised themselves, much learning takes place at work through co-operation and interaction with colleagues and clients and various other networks. However, as perceived by the designers, social interaction is not only a way of learning but also a focus of day-to-day learning in practice. For example, sustaining a cosy atmosphere facilitating team practice and functional relationships between colleagues and other partners in order to accomplish the job is an important focus of everyday learning. This is where former experiences in various work settings also have a decisive role, as reported above.

From the information obtained during observations at the two workplaces, it can thus be argued that designers' technical performance of work tasks, learning in the course of that performance and social relations in the workplace are not separate elements of the work process. Instead, they are closely connected with each other (see also Alvesson 2001). The observations and interviews suggest also that collaboration among various groupings and networks (e.g. Nardi et. al. 2002) and the negotiations taking place in such contexts are a pervasive element of all problem-solving in working life. In technical design this network comprises, in addition to the design team the firm's clients and the people who will implement the designs, that is the workers responsible for manufacturing the final product.

The shared and social nature of designers' practice and learning also appeared in situations where it was not possible to find common ground over carrying out the job. Although designers' shared practice seemed to progress very smoothly for most of the time, occasional conflicts between designers also took place. The conflicting nature of practice may also manifest itself as a conflict between the official organisational rhetoric and practice conducted and experienced on the ground by designers themselves. Employees seek to maintain a good working atmosphere for their shared practice. Practice is, however, temporary and situational and in a state of constant flux. Working goals and plans are redefined during processes and projects. Problems and their solutions are also negotiated and constructed anew on each occasion in teams and groups.

Everyday practice may thus include disagreement and dissension, which may cause harm and challenges to social learning, but which also have a function in creating solidarity between team members against external forces. A diversity of realities exists within the processes going on in the workplace. When participating in shared practices workers have to face different social relations, as well as constant change and conflict situations. Shared practices include elements which, on the one hand, give work an appearance of order and on the other hand, make it look messy and even sometimes impossible.

The constant change in practices also has implications for constant learning. One must learn to know, understand and, above all, trust the various work processes and the team's ability to jointly accomplish the tasks it is set. Participating in working practices should thus be seen as learning, and as the best possible learning in this context of change (Billett 2004a). Team practices also include the delicate handling of disagreements, which are not, contrary to some previous opinion (c.f. West 1996), necessarily a negative feature. On the contrary, to survive one's everyday work involves doing and learning things with others and sometimes disagreeing with them. The findings of this study indicate that disagreement can even strengthen a team's ability to co-operate and help it to maintain functional social relations (Lahti, Eteläpelto & Siitari 2004; conflict as challenge). Social relations at work and learning in and from them are, nonetheless, a double-edged sword. They are perceived simultaneously both as a delight and as a source of pain, as emerged from designers' stories about the role of previous experience for their learning (see also article II).

Design engineers' everyday practice involves continuous joint negotiations and renegotiations about how to resolve new problematic situations. In the two companies studied an individual designer typically belonged to and worked in various teams whose composition varied every time a new project began or ended. As Carkett (2004) found in her ethnographic study of creativity of engineers in an aerospace company, design does not take place in a vacuum but is a social skill and it cannot be separated from social relationships, culture and business needs. Consequently, learning to interact with different people in situations like these can be assumed to be important. It is, therefore, rather difficult to specify what modes of collaboration or participation are the most suitable for organizations in general in producing learning or even economic profit. Instead, it may be more useful to pay attention to the continually changing processes and practices of work and try to analyse situationally the different options for practice that emerge from the various aims and tasks of the job itself. It is practice which teaches us most while, at the same time, it also teaches us something about ourselves as practitioners, as has also been shown above.

7 DISCUSSION – SEARCHING FOR NEW METAPHORS AND PRACTICES IN LEARNING AT WORK

While the findings of each phase of the study were reflected on in previous chapters and discussed in articles I–V, this last section of the report aims at presenting an understanding of the industrial designers' practice and learning on the basis of the empirical findings and recent debate in the field. The last section of chapter six brought together the central findings from the different phases of the study and drew conclusions about how designers saw their learning in their day-to-day practice. It also summarised what kind of a picture of learning can be assembled from observations in authentic work settings. This chapter discusses the phenomenon of workplace learning from a more general perspective and makes suggestions on how to define workplace practices and learning in them. In addition, the aim is to critically discuss the methodological choices made during the research process. Also, what kinds of further conclusions can be drawn on the basis of the findings will be discussed. How the findings relate, for instance, to organisational practices and vocational education will be brought under closer scrutiny.

The results of this study, supported by the recent literature on the topic, showed that learning at work is a multi-faceted phenomenon. It thus seems that it cannot be reduced to the set of learning outcomes predefined by an employer or organization. Instead, it must be approached as a set of continually changing processes from both the individual worker's and social community's points of view. Next, workplace learning will be discussed in terms of three partly overlapping strands or ideas about it which have until recently dominated the research and approaches in the field. As this discussion will show, some of these ideas should be reconsidered. First strand concerns the way workplace learning has been approached and described using terms and concepts borrowed from formal education. The second is the tendency to see it as mostly informal. It will be argued here, however, that the term informal does not describe the diversity of the practical learning that occurs in workplaces well

enough, and it cannot thus be reduced to this one concept only. The third strand concerns seeing workplace learning through metaphors either of knowledge acquisition or participation, that is; that learning in the work contexts is either an individual effort or occurs mostly through participatory communal practices. Instead, it will be suggested that both individual agency and social life are important aspects of learning in the workplace and, that there are constant interrelations between them.

7.1 Criticising the approaches borrowed from formal education

Even though the nature and processes of workplace learning have recently attracted growing interest and its significance has been extensively acknowledged, it has been pointed out that much writing on workplace learning is still strongly shaped by the authors' understandings of learning in formal educational situations (Beckett & Hager 2002; Elkjaer 2003; Hager 2004a). In addition, as Hager (2004a) argues, a common understanding of learning uncritically incorporates assumptions derived from previous formal learning experiences. The findings of the present study and the views presented in recent reports show, however, that learning in the workplace cannot be described or explained only with the help of concepts and ideas borrowed from formal education. Instead, it should be addressed in terms of its own vocabulary and processes.

One of the most common and everyday conceptions of learning and educational procedures, and also learning which takes place in the work context, is to see it through its results and outcomes. This view of learning is also seen as a process where the human mind is filled with the content of knowledge. Although learning, and especially workplace learning, has been shown to be much more than acquiring new knowledge (see e.g. Brown & Duguid 2001; Darrah 1996; Lave & Wenger 1991; Orr 1996), it has been argued that much educational policy and practice are still rooted in the learning-as-product view (see Hager 2004a). This can clearly be seen, for instance, in splitting vocational competence into skills which novice students and workers should acquire regardless of the situation or context where this skill or competence is used. The dominant learning-as-product view also involves the assumption that the products of learning are relatively stable over time. In addition, there is a replicability assumption – that the learning of different learners can be literally the same or identical (Hager 2004a).

According to Hager such views face a growing number of difficulties when they are applied to the learning which takes place in work practices. First, the learning-as-result view leads to the problem of separating theory and practice. As discussed earlier in this report (see chapter 6) theory and practice should be seen as fused as there are no general solutions to problems which can be derived from theory alone. Second, learning at work, and in life in general,

seems to continue and take on new forms during its course. Rather than seeing learning and knowledge as front-end and obtained during formal education, it would be better viewed as a gradual process of growing understanding and development that continues throughout working life. This is also what the designers narrated about the development of their own way of seeing their technical work and how knowledge accumulates, how they learn new things every day, and what they told about the relation of theory and practice for their learning. Finally, problems may emerge if learning is approached as only a positive and unproblematic phenomenon. Rather, as shown in this study, work practice and learning in it, involve conflicts and disagreement which have to be solved case by case in messy and open-ended everyday coping. Power relations and cultural values, among others, may also lead to situations where even the wrong things or something which is not supposed to be learned, is learned, or where there are not enough learning opportunities or guidance available in the first place in organisations (see e.g. Billett 2001a, 83–86).

Despite the essential role of theoretical knowledge for learning at work, it is argued here that learning, more than is generally assumed, also appears through the processes of practical doing (see also e.g. Beckett & Hager 2002; Billett 2003b; Hager 2004b). This is shown in this study in the designers' conceptions of learning as doing the job itself and in the numerous examples of how experiential, social and shared processes of practice are manifested in the work as such. It seems to be the case that the metaphors of learning as the acquisition of knowledge or as participation are both accepted in current studies and the literature in the area of workplace learning. Practical applications to improve and increase learning at work, however, are not so numerous. Many practices in the workplace and in vocational education continue to neglect the processes of workplace learning relying instead on methods which emerge from seeing learning more through its outcomes than its processes. Similar difficulties seem to crop up when learning in the workplace is approached in terms of informal learning. This will be discussed next.

7.2 Describing learning in the workplace as informal

As has been argued in previous chapters learning and the actual doing of the job cannot be separated; rather they are intertwined elements of working practices with learning forming a ubiquitous part of practice (see e.g. Lave 1993). The designers in the present study, for instance, saw their learning mostly as the same as doing the job (see article I). Also the common practice of labelling workplaces as informal (see e.g. Marsick & Watkins 1990) learning environments reveals their ambiguous status in terms of learning. Even though the use of the term informal would appear to be an attempt to acknowledge those elements of learning which it is not possible to clothe in words, and which

are connected to doing the job, such labels for workplace learning (non-formal, informal) persist, usually without critical appraisal. Therefore the terms and labels informal or non-formal seem not to be able to capture the characteristics of workplace learning exhaustively.

The term informal can also be criticized on the grounds that there have not been enough serious attempts to describe and analyse what this informality specifically includes. As has been demonstrated previously in this report and in recent writing about learning at work, it is much more structured and organised, and even pedagogical, than might have been expected (see Billett 2001a, 13–40). The complex nature of informal learning has been admitted recently (see Eraut 2004), but the problem is, that for learners themselves learning is largely invisible and taken for granted and regarded as part of a person's general capability. The situation is similar with respect to the numerous cultural, contextual and structural mechanisms, as well as individual worker's goals by which continuity of practice is sustained and reproduced. Learning experiences are thus highly structured and formalised by the community's norms and practices.

When looking closer the nature of workplace learning as informal and ubiquitous, it may be argued that its features can be mapped, at least some of its parts. In the present study, for example, the term informal seemed to include doing the job itself, the role of the individual worker's previous experience, and the ever changing nature of situated and contextual working environments. On the basis of the designers' stories previous work experience has an essential role in understanding and coping in the domain of social relations. Social interaction and working within various networks is an important element of what is learned through work. Further examination of the role of experience for learning at work showed that it is important in achieving a holistic understanding of work processes. This, in turn, helps workers to gain a feeling that their work is under control and can be accomplished satisfactorily. Another element that can arguably be included in the term informal is how designers create their own individual view of doing their job, utilizing their experience in other areas of life as well. Informality of learning was also found to be connected to the constitution of social relations, sustaining of a cosy atmosphere and handling of disagreement in interim and reconstructed circumstances of workplace reality.

Consequently, more important than giving up the attempt to describe learning at work saying it is merely informal, would be to analyse what this informality includes and see what kinds of learning processes and learning experiences emerge. It should be possible to distinguish subprocesses of informal learning or at least some features which characterises its processes. It is presumably evident, however, that much of the nature and processes of workplace learning, as tightly related to the job itself, is likely to remain in obscurity. Hence more studies of workplace learning processes as situated and constantly changing in various occupations and contexts, continue to be needed.

7.3 The interdependence between individual and social practice in the workplace

Although the individual aspect of learning has dominated research in the area of workplace learning, the phenomenon has also more recently been approached through the participation metaphor, seeing the collaborative and communal processes of workplaces as the most essential elements (Hutchins 1993; Hutchins & Klausen 1998). In addition, during recent years, studies and theory have concentrated on emphasising everyday working practices as social communities which may be influenced by the organisational context. Among others, Hodkinson et. al. (2004) criticize the current tendency to approach workplace learning primarily from the paradigm which prioritises the social and organizational dimensions of learning. Instead, relatively little research on learning at work that focuses on the role and the significance of the individual worker/learner has been conducted. Approaching workplace learning as purely social, it has been claimed (see Hodkinson et. al. 2004), includes the risk of seeing the individual as subsumed within it.

More recently it has been argued that there is even less work which successfully integrates the issues of individual learners into predominantly social theories of learning (e.g. Hodkinson et. al. 2004). Some of the most recent developments in the research and theorizing of workplace learning, however, have their focus on seeing both the individual's previous life and work experience and the social and situational aspects of work practice as of importance in to increasing our understanding how learning at work takes place (e.g. Billett 2002a; Billett & Somerville 2004; Hodkinson & Hodkinson 2004).

Learning then is to be seen as a holistic and ubiquitous process that takes place through normal working practices. Hodkinson et. al. (2004), among others, argue in much same vein as Beckett and Hager (2002), that the individual and social, agency and structure are blended, thereby losing much significance as separate issues. Understanding and theorising workplace learning should thus avoid either over-emphasizing individual agency or to sliping into organizational (contextual) and cultural determinism. On the contrary, they are interrelated and constituted by each other in every-day work practices. Learning involves a complex and often reflexive interrelationship between the community of practice, individual dispositions to learning, inequalities of position and capital, and wider influences upon, and attributes of, the field of work in question. Therefore workplace learning cannot be understood through the abstraction of any of these elements at the cost of marginalizing the rest.

That the social and individual aspects of learning are in practice inseparable and interdependent is also shown in the findings of this study. This can be seen in the results in the importance of the fact that individual experience and various aspects of social and situational learning are present

simultaneously in the workplace. Therefore, whether learning at work was approached through narrative interviews or observations of workers' interactional practice, the central conclusion remains that employees' previous experience and the importance of social and shared practice emerged as important aspects of learning at work. The results obtained from the interview, and the observation data, analysed with various methods, are in part parallel. Thus they show that both the social and individual aspects appear to be essential in everyday practice in order to accomplish the tasks and projects at hand.

Emphasising the view that workplace learning is neither wholly socially nor individually determined, the interdependence between the two has been subjected to closer scrutiny. Billett (2003a; 2004b), for instance, proposes that distinct contributions will be found from the historical, cultural and contextual sources of knowledge located in workplaces. In his study he showed that contextual and shared knowledge is used in those many situations in which co-operation and interaction with colleagues, clients and various networks takes place. As Billett also shows, this kind of shared learning emerges and is reconstituted in various situations in which, for instance, a cosy atmosphere of team practice and functional relationships are sustained, or the experience and expertise of colleagues are called on in helping to solve everyday problems. Billett (2003a) goes on to say that these contributions from cultural and contextual sources of knowledge are shaped and privileged by situational practices. Also, for instance, Engeström & Middleton (1998) state that culturally derived activities are held to be constituted situationally through local interactions and negotiations, and, according to Suchman (1998), through local orderings.

The present study also indicated that shared practices seemed to be temporary and thus negotiated and constructed anew with each work task or situation in teams and groups. In the same way, the goals of an individual worker, or of a team, are redefined during processes and across projects. However, individual's prior experience and life history (individual ontogeny) mediate these cultural and situational contributions in ways that shape individuals' actions and contribute to their ongoing development as professionals. The findings of this study showed, for example, that designers emphasised the importance of their own way of doing things. Also constant negotiation between peoples' different views changes the way they see themselves as workers and how they conduct their practices. In fact, changes in processes take place at workplaces more widely than is commonly understood (Billett & Somerville 2004). To sum up, individuals seem not to be just involuntary actors determined by their environment, but they actively constitute the reality in which they live. This activity or practice, in turn, emerges situationally from their previous experience but not, of course, always in the same way. And when practices are changed, so are the people involved and their views about themselves as workers and human beings. What learning will occur, however, cannot necessarily be predetermined, since situations are

very different from each other, and very many factors determine those situations and learning in them at any given time.

Consequently, professional development and learning comprises the dual process of individual change and the remaking of cultural and contextual practices. It has thus been argued that, analytically, individual, group, and organisational learning processes should be considered simultaneously and as intertwined. One example of this kind of a modelling is the process model of learning at work (Järvinen & Poikela 2001). In this model, individual, group and organisational learning are elaborated simultaneously. The individual and social are interdependent but it also should be remembered, that this interdependence is relational, depending on every new situation in day-to-day working practices (Billett 2004b). Not only do the larger structural and cultural aspects of work constitute the individual, but situationally changing and interim practices as well. Individual experiences are under constant reconstruction along with their engagement with immediate and situated practice. Every individual in the workplaces carries with him or her values and competence gathered earlier, also from other areas of life. Individuals' own intentionality also plays a key role in these processes.

Expertise, competence or learning should also be depicted in terms of how vocational practice is constituted situationally and influences the activities in which participants engage relationally and change through that participation. Although the results obtained from this study do not directly show (and this was not the primary aim of the study) how the individual or personal meanings given to learning are shaped along with individuals' life histories, they, nonetheless, support the conclusion that it is important to take individual goals, personal views about doing one's job and experience related to work contexts into account. In particular, how the interdependence of individual and social practices together constructs the situated and goal-based interaction and sharing, which takes place in teams, is dependent on both of these aspects. It can be stated, thus, that the most important conclusion arising from the findings of this study is that individual aspects, for instance, the essential role of the subject's accumulated previous work experience and the social life of working practices, should be treaded as intertwined in the phenomenon of workplace learning.

7.4 Learning in the workplace as inquiry – Pragmatics as promising direction for further studies

If doing (working, for example) and learning are seen as intertwined and holistic, (see Beckett & Hager 2002) we should also give up the other dualisms traditionally connected with learning (such as individual/social) and thus search for a new metaphor for learning at work. In addition to metaphors of learning such as the acquisition of knowledge and learning as participation,

more adequate metaphors have been developed from the ideas of pragmatics. Elkjaer (2003), for example, shows how the metaphor of *inquiry* (the concept is originally from Dewey) functions in organisational learning context. The concept of inquiry is a synthesis between the two metaphors of acquisition and participation. In the inquiry metaphor learning and utilizing experience is seen as a continuous process, a transaction between the individual and the environment in which both individual and environment change and develop all the time. More generally, it is a process enabling the individual to manage better in his or her environment (Kivinen ja Ristelä 2003). One cannot act, however, in a vacuum but action and learning are rooted in a situation or a particular problem. Previous experiences from similar situations are used and transferred, if possible, to similar situations. Learning is not only becoming something, but involves a constant change of the reality around us in which we as individuals take part by (re)constituting it, as shown in the findings of this study. This comes quite close to the pragmatist idea that learning is a change in action, which aims at development and growth (Kivinen & Ristelä 2000).

Hager (2004), on the other hand, offers an even better metaphor for capturing learning as a process, i.e., *construction (or re-construction*), which is also a Deweyan idea. He argues that as a metaphor construction is superior to inquiry metaphor as it better suggests the broad scope of the changes that are implicated in Deweyan learning. The construction metaphor encapsulates the construction/re-construction of learning, of the learner's self, and of the environment (world), which includes the self; in other words, it helps us concentrate on the interplay between learning and the environment in which learning takes place (see also Dewey 1916, 139–163; Dewey 1999, 172–194).

The findings of this study can be seen as connected, at least in part to the pragmatist ideas of Dewey, for instance. Pragmatics can be thus seen as one promising direction in which the findings point possibly leading to a new focus of investigation. Since it is obviously quite unlikely that one all-inclusive theory of workplace learning will be found, it would be tempting to think that learning takes place in terms of practical doing and goals-setting for doing things better (see Elkjaer 2003; Kivinen & Ristelä 2000, 8–15). Thus it makes no sense to separate theory and practice from each other but rather to fuse them to enable better or more functional practices. In addition, on the basis of pragmatist ideas, therefore, there is no value in perceiving learning as either individual or social, as they take place simultaneously in the workplace. They are both products of human beings and knowledge. Neither does make it sense to separate learning and doing from each other, as pragmatists see them as a single holistic entity the goal of which is to cope better with the surrounding environment and develop, for instance, in the domain of work.

7.5 Methodological discussion – what could have been done differently?

A methodological discussion is included in each article produced during the research process. The methodological choices are described in more detail in chapter 5. Given the ethnographic framework emphasised here, the methodological and strategic choices and interpretations of the results should be discussed more in terms of their practical functionality, plausibility and transferability than in terms of the conventional validity and reliability (Davies 1999; Brewer 2000; Patton 2002; Seale 2004b). For this reason emphasis in this section is on the general justification of methodological choices through themes such as the reflexivity of the research process, viability and transferability of the findings, and ethical issues.

The methodological choices made in the course of this study can be seen as pragmatic strategies to find the most appropriate methods to describe the phenomenon under study and combine them when warranted (see Patton 2002, 71–72; Seale 2004b). The choices made during the research process can also be seen as qualitative choices in which craft skills, creativity and reflexivity are integrated. The ethnographic approach used here was seen as the most appropriate in attaining the aims set for this research, that is, to describe and understand designers' work practice and learning in the course of it. Therefore, for the purpose of investigating how workers themselves perceive their learning at work, and how they make sense of their practices and participation as members of a team or as part of a larger work context, the ethnographic approach was a natural choice.

The choice of an ethnographic strategy can also be argued to be appropriate due to its use of various methods of data collection and analysis (see chapter 5). It has also been argued that validity is more likely if a variety of methods are used (Davies 1999, 85; Patton 2002, 555–563; Silverman 2001, 233). Objective observations and subjective interviews would thus be seen as complementary. A pragmatic stance aims to supersede one-sided paradigm allegiance by increasing the concrete and practical methodological options available to researchers and evaluators. Such pragmatism means judging the quality of a study by its intended purposes, available recourses and procedures followed, and the results obtained, all within a particular context (Patton 2002, 71–72).

However, one could claim that utilizing different data types and analysing them is not ethnography as such. What marks their ethnographic application in this study, however, is that these methods have been used to study people in naturally occurring settings or fields in which the intent has been to explore the meanings of the setting and its activities from the inside (see Brewer 2000, 27). This can also be seen in the procedure, in which the interviews followed the observations and were thus based on the ideas and interpretations obtained

from the research settings. Further, after the data gathering, suitable methods of analysis were chosen to answer the specific research questions.

While the selection of a research strategy and design is usually based on practical starting points, so also are the ways previous studies and theories are used as a foundation for the research. One fundamental reason to study workplace learning processes from the workers' point of view was the paucity of basic research conducted in the area at the commencement of this research process. The phenomenon was ill-defined and still in its infancy and conceptual starting points had to be built from the few materials available. This is why a holistic, process-oriented and data-driven methodology was adopted.

Although recently research in the field has snowballed, the finding that learning is conducted by the workers themselves can be argued to be an important contribution to research in the area. Accordingly, although the use of ethnography was due to the qualitative approach demanded at the time the study was begun, the selection of methods of analysis, instead, was decided along with the new questions which emerged from the initial analysis. In the same way, the final selection of the target companies was wholly practical, i.e., they were the only two organisations willing to co-operate. This naturally also has implications for the transferability of the results since only two work contexts were investigated (see Silverman 2001, 248–254). Therefore, the question following from this still remains. Namely, would it be possible to find organisations in the topic even better suited to investigating designers' learning in the workplace? This is in fact highly probable. However, although the selection of organisations took place on the basis of practicality, I had, as a researcher the possibility to decide, for instance, who to observe and who to ask to be interviewed. In addition, I was able to direct the collection of materials and concentrate on issues needed at different points in time during the process.

As stated in chapter 5, being reflexive is one way through which credibility can be evaluated. Reflexivity can be seen as an alternative to the traditional criteria by which ethnographic data is normally judged (see Denzin & Lincoln 1998, 278). In the name of good reflexive practice, an attempt has been made to describe and assess as profoundly as possible the choices made during the process (see chapter 4). Constant comparison of ideas emerging from the materials has also been done, as well as cross-checking information obtained during the observations periods (by returning to the same topic, asking the same question under varying circumstances and checking verbal assertions with observations) to ensure credibility of the results (Davies 1999, 86). This formed a natural part of the ethnographic process in this study as ideas emerging from observations could be compared to ideas emerging from interviews and vice versa. Also in this section, a few things which could have been done differently will be subjected to further consideration (Brewer 2000, 130–133; Seale 2004b). However, in the strictest sense, the criterion of reliability and validity does not apply in ethnographic research. Although, according to the traditional criterion of reliability, the ethnographic research conducted here is not replicable by another researcher or in other contexts, other methods to ensure the best possible credibility and plausibility are available and were used.

In ethnographic and in qualitative research in general, the issues of credibility, plausibility and transferability are intertwined. To attain the best possible level of credibility, for instance, I have attempted to be systematic in both the data collection (writing field notes systematically and submitting extended extracts of field notes for the reader to evaluate) and data analysis (see Patton 2002, 553–563; Silverman 2001, 227–228). It is assumed that the extracts from the field notes and taped work talk have given the reader an opportunity to evaluate the reasonableness of the author's interpretations. Another significant factor regarding the credibility of the findings, which is also related to the plausibility of the results, is the use of triangulation of the data collection methods and methods of analysis, which are integral parts of the ethnographic method (Patton 2002, 555–563; Silverman 2001, 233). Another evidence of plausibility of the findings is that with help of various methods (data collection and analysis) I repeatedly encountered identical and parallel ideas or interpretations concerning the designers' experiences of their learning at work.

Plausibility of results has traditionally concerned the truthfulness of the findings. In addition to the triangulation of data collection methods referred to above, respondent validation in a small scale was also used. This means that the subjects of the study have been asked to give feedback (see e.g. Patton 2002, 560–561; Silverman 2001, 235–236) on the truthfulness of the interpretations (see article I). This was done after the articles had been written. The plausibility of the respondent validation itself, however, is possibly reduced by the fact that, the further the research process proceeded, the fewer the number of people who were able to provide me with feedback. Reason for this was practical; many of the designers had changed their jobs or their workplace during the process, or they could not be reached for other reasons. However, the small group of subjects involved gave the kinds of comments which supported the interpretations of the researcher.

The findings have thus arguably been able to capture some of the essential elements of designers' practice and their learning in the course of it. At least, according the comments given after the interviews, for some workers the interview offered an opportunity to analyse and reflect on their own practice. This may be the best gift which ethnography and fieldwork can bestow on the subjects of a study (see also Button 2000). However, one should be aware of the fact that many things may have remained untold and thus not included in the stories constructed, for instance, in interviews. What also could have also been done differently during the data collection is to have used longer periods of observations in both companies in order to verify and deepen the interpretations. It is to be doubted, however, whether it would have been possible to determine exactly how much time should optimally have been spent in the settings.

Further, concerning the data analysis, a few issues should be discussed. Despite the fact that adopted membership categorization analysis was used as a part of the ethnographic approach in this study, some aspects of commonplace practices of working life might also have been approached using ethnomethodology. Thus the recorded work talk would have benefited from

conversation or discourse analysis. In that case, more of the structural elements of the interaction and more background information about the contexts of workplace as structuring its power relations may have been revealed (see Heritage 1984, 241–244; Silverman 2001, 167). With help of ethnomethodology it may have been possible to better grasp the constitutive practices of how designers do what they do, and the "interactional what" of their activities (Button 2000). From the point of view of the research problems and study design, other kinds of choices would then have been needed. Additionally, one may be sceptical of how well ethnomethodology alone would have been able to reveal something about designers' learning, or to answer to the research questions as they are presented. They might however, have been able to give supplementary information about phenomenon and the contexts under study.

A critique often levelled at ethnographic research is its lack of generalizability. It may be argued that generalizability, in the sense that the results of this study, for instance, could be applied to workplace practices in general, is inappropriate as a criterion in interpretative research (see Davies 1999). However, without any promise of generalizable results ethnography is nothing. Therefore, generalizability should rather be discussed in terms of transferability and theoretical inference. By transferability it is meant that the findings can be extended to other cases, judged to be similar or common in the field and thus give a direction for the interpretation of findings obtained from other contexts (Davies 1999, 90–91; Kvale 1996, 231–235). It is more usual, however, that acceptable examples of generalization are achieved by seeing them in the context of a particular theoretical debate (Davies 1999, 91; Silverman 2001, 249). Consequently, it is argued that the main findings of this study may have some transferability, since they are in line with the recent discussion taking place in the area of workplace learning (see e.g. Billett 2001a; Beckett & Hager 2002; Eraut et. al. 1998a; Gerber 1998; Hager 2004a), and especially in the field of designers' learning (see e.g. Bucciarelli 1994, 2003; Rasmussen 2002; Sharrock & Button 1997; Schön 1987).

One reservation regarding the transferability of the findings of this study is, however, that learning seems to be so context-dependent and situated that the actual circumstances of workplaces should be taken into account when examining the practices of any work setting. The questions of plausibility and transferability can therefore also be left to the target audience, which can evaluate the significance and implications of the results at hand. It has to be remembered, additionally, that as an educationalist I did not have an adequate understanding of the requirements of the vocational expertise of designers. This is one reason why further studies in various contexts, and in concert with domain-specific experts, would be needed to elucidate such domain-specific requirements for learning at work.

Another reservation emerging from the findings of this study is that the latter are not necessarily applicable to all kinds of work. Whereas design work can be characterised as project-based, team-based, networked and social and, thus, as rather demanding modern knowledge work, there are still a number of occupations in which these characteristics are not so important (production-line

work or cashier, for example). Rather, such occupations can be characterised as solitary and routine in which the aspects of sociability and responsibility for projects, for instance, have a minor role (see e.g. Blackler 1995; Järvinen, Koivisto & Poikela 2000, 44–53). There are contradictory trends in the expansion of the learning organisation or knowledge organisation and in the routinization of many tasks (so called McDonaldization) going on in society. Therefore, various trends are taking place simultaneously, and those who study learning at work should be aware of these contradictory trends (Järvinen & Poikela 2001). Consequently, there is no general applicability from the characteristics of design work to all kinds of work.

A few general remarks concerning the use of ethnography should also be made. Firstly, the researchers should be aware that various biases or theoretical ideas are usually present in his or her mind before entering settings, despite he attempts to ignore them. Hence, in the present study, I already had a few ideas concerning the nature of workplace learning as a social and collaborative activity. Although those ideas were honed during the research process, they were nonetheless there in my mind and may thus have had an influence on what I chose to observe or ask and how I chose to interpret the initial findings. Secondly, the degree to which the ethnographic approach itself has an impact on the findings should be considered. Namely, ethnography is itself an approach which applauds the fuzziness and the messiness of the phenomenon under study. It should be deliberated, therefore, to what extent ethnography itself produces this messiness, since it is predisposed to find reality messy. In other words, to what extent are the findings a consequence of the methods utilised.

Ethical issues. In conducting ethnography, or any qualitative study, certain standard ethical issues need to be taken into account throughout the research process. These are consent, confidentiality and trust (Ryen 2004), which are all closely linked together in research practice. Ethical issues and practical choices made on the basis of these are, however, rarely unambiguous or easy, as ethichs is itself a socially constituted and situated field. It is probable, therefore, that the most profound opinions and thoughts of the participants concerning the ethics of the study cannot be reached.

The most basic ethical issue concerns informed consent, which means that research subjects are told that they are being researched, they know what they are participating in, they know as far as possible the intentions of the researcher, they participate voluntarily and that they have the right to withdraw at any time (Ryen 2004; Silverman 2001, 270–271). The issues and challenges relating to entering the field and selecting the interviewees were also discussed in chapter 5. It was noted that all the participants in the two organisations expressed willingness to participate in interviews as well as be observed in their daily businesses. There was no reason to doubt their sincerity despite the fact that in the case of one of the organisation conducted an ancillary study on familiarization practices was a condition of entry to the setting in the first place. However, it may be assumed that in the interviews I was told as much as the participants wanted to tell me about their conceptions and

experiences in the name of their voluntary participation. In addition, it was clearly indicated to me, and in some cases negotiated with me, when there were meetings or occasions where I was not welcome, or if no useful information for the purposes of this study would be gained. Obviously the topic of the study did not oblige the workers to give me too personal or confidential information, which might them to withdraw.

Confidentiality in terms of maintenance the participants' anonymity was a self evident condition to starting the study in the two organisations. Instead, the names of the companies were not required to kept secret, although they were referred by pseudonyms in the reports, as were the names of the individual interviewees. As mentioned in chapter 5, videotaping was prohibited in both companies. The reason for this is understandable: to protect the products of the organisation against rivals, since they usually are in the form of pictures and graphics. It was also arranged that the whole manuscript would be read by the managers before publication so that no business secrets would let slip in the articles due to my careless writing. I was not, however, asked to make any corrections to the manuscripts. From the beginning of the research process there was also an agreement about the data and materials being for my use only. It is also probable that conducting the research has done no harm to the participants in terms of their relative job security, for instance (see Ryen 2004).

As discussed in the chapter 5, I attempted to build trust between me and the participants by behaving either as ignorant of or honestly interested in the area of engineering and design. Presumably, I would thus make them feel comfortable and empowered concerning their own expertise while emphasising that I was interested nothing but in their own conceptions and experiences of learning, and that their ideas were valuable as such. The jottings in my field diary, however, tell that at the beginning of some interview situations (especially during the first ones) I felt some of the interviewees may have been a little overwhelmed and looked "up" at me as if to an important researcher to whom to they may not have anything important to say. Or the interviewee (a couple of foremen) was not willing to speak directly about his own experience but in a general manner from the company's point of view. As a researcher I also may have felt that if an interviewee did not tell me what I expected to hear the interview was ruined. Later, however, these "ruined" interviews proved to be the most successful and informative ones due to the plenitude of their descriptions of design practice and personal views. Though trust building is not a quick process, the interview situations usually ended in mutual understanding and a good atmosphere. From the trust and fidelity point of view it is quite obvious, however, that many emotions (and the ones which are unconsciously held back) during the data collection periods may have had an influence on the interpretations of the findings.

7.6 Further challenges for research, work practices and vocational education practice

In this section suggestions for further research and practical challenges will be presented on the basis of findings and conclusions of this study. The challenges of both research and practice spread out in many directions, and many important subjects for further investigation emerged. Various further ideas for researching designers' learning in their practice and how the formal education of designers could be developed in connection with these ideas will be disclosed. In addition, more general suggestions and contributions concerning the guidance of workplace learning will be given, and the challenges of guiding and assessing of workplace learning in the vocational education context will be examined. More effective integration between education and working life is called for.

One evident challenge for further elaborations that emerges from the results of this study is the challenge of connecting the individual and social aspects of workplace learning both theoretically and empirically. Empirically, a concrete challenge is how to connect these aspects analytically and methodologically. From the perspectives of workplace pratice and learning a futher challenge may be how to take these both aspects simultaneously into account when developing work practices and enhancing learning through these practices.

Designers' learning and guidance in the workplace and in education. As noted recently in the studies of designers' practice, and in the results of present study, designers' work can no longer be regarded as an individual and linear problem solving procedure driven by management and assessment needs. Rather it should be seen as team-based, social and networked action in messy the practices of everyday working.

As the consequence of understanding designers' work as such, the dichotomy between being a technically or socially competent worker should be questioned (see Ludvigsen, Havnes & Lahn 2003). Accordingly, efforts at managing and guiding design to the direction of understanding these as holistic and social processes would be a useful way of outlining designers' practice. Therefore, further research should address team-based design practices and the constitution of interaction during design processes. Additionally, context-bound investigations about the role of collaboration in expanding networks are needed. Ethnography as a methodology may be a solution in investigations of this kind (see Button 2000). Another issue that merits study would be how a personal view of working and learning in design develops out of individual goals, accumulated experiences and life history during one's career. How such a personal view contributes to social and interactive aspect of learning at work should also be put under closer scrutiny.

Increased concern has been voiced about the role of formal education in the case of engineers and designers, and about technical pedagogy in general,

which is criticised as continuing to be rational and linear. Real practice, however, includes many unpredictable aspects, which are mostly shaped by anticipated and situated elements of social interaction and the devious nature of the design process (see e.g. Bucciarelli 2003; Mawson 2003; McGormick 2004). Traditional models of the design process have been argued (see Mawson 2003) to be based on fundamental misunderstandings of how professional designers actually work. If the target of vocational education in the case of designers is to develop innovative, risk-taking, reflective problem-solvers, learning tasks and larger authentic WBL-projects, for instance, should be designed as open-ended, context-bound, respectively. The learning tasks should also encourage experimentation and creative information gathering, and allow open and optional outcomes. Therefore, open and flexible learning environments for the various needs of design students should be developed in order to be able to take the interdependence of the individual and social aspects of learning into account.

Challenges for the workplace curriculum. The fact that the individual and social aspects of learning are interdependent and intertwined in work practices (at least in the case of designers), raises the questions of how it is possible to obtain a coherent picture of the phenomenon, and how learning so reliant on practice itself can be guided. One answer is that it is not possible, it cannot be guided, at least totally, in the desired directions. However, strategies for a "learning curriculum" (see e.g. Billett 2001a, 140–196) or "corporate curriculum" (Kessels 2004) in the workplace have been presented. It is emphasised that managing successful guided learning at work requires positive relationships, an open, prepared positive culture for learning, clearly set goals and awareness on the part of all the participants about what should be done and learned. In spite of the requirements described above, however, either learning affordances are often not available or something which was not intent will be learned as well. It may be argued further, that the aim of a learning curriculum for the workplace mostly serves the development of occupation-dependent expertise in various vocational areas, while many aspects of learning remain in the shadows. Thus everything that is learned in the workplace cannot be guided, even if this were desirable.

One such aspect derived from the findings of this study which still requires more profound investigation, concerns social relations and their situatedness as a natural phenomenon in the workplace. Another aspect concerns the perceptions and meanings which are given to individual experiences accumulated in the course of the working career. What is suggested here is, concerning the latter that, it must be accepted that the development of expertise takes time. Personal goals and other important things in life for workers should also be taken into account when designing the learning curriculum. While the practices of various workplaces seem to be context and vocation bound and situated, it may be argued that means of guidance should be localised and jointly approved by the workers themselves. How the guidance of learning will be implemented, what the goals of learning are, and

who does the guiding (a mentor or colleague, for instance), are thus best decided by the workers and their managers by themselves.

On the basis of the findings of this study it is suggested that different kinds of jobs, tasks and work processes should be analysed more in the contemporary workplace. In addition, especially how these processes and practices are related to each other in larger entities should be analysed in greater depth. The people who are actually practicing there should do this inside the organization, not people from outside the organization or team because the workers themselves are constantly reconstituting their practices. Further, the role of management is to support all kinds of developmental efforts made in organisation and teams, not to control them (Järvinen & Poikela 2001). Thus the focus should be on learning projects which develop their own practices and which are organised by the employees themselves (see Järvinen, Koivisto & Poikela 2000, 159–163).

Another interesting view of workplace learning concerns how to manage and design effective learning so that the goals of both individual workers, teams and the larger organisation can be achieved. Or how to motivate individual workers and learners to achieve the desired learning outcomes as determined by the employer. On the basis of the results of this study, one can be quite sceptical also about the effects of various training programmes conducted in organisations (see Angervall & Thång 2003). This is because workplaces contain a range of social situations, and it should be accepted that different moves and choices lead to different things from an individual's point of view and, therefore, are not always desired by the employer. Workplace training can also have undesired effects, and it does not always mean the same thing for every worker because workers are individuals who bring their own goals, life histories and motives with them. Consequently, one important question both for further studies and practice is how to develop workplaces as open and flexible learning environments (see also Kessels 2004). The findings from the present study suggest that opportunities to develop both individual and social agency should be created, if we wish develop work and learning through it.

It should also be considered that different groups of employees have access to different kinds of experiences within the organisation and therefore may put forward different definitions of problems and solutions according to how they are located in the organisation. At the same time, the social and cultural life of the workplaces and of smaller teams often differs, even radically, from the official rhetoric of work organisations, as was also indicated by the present research (see also Rhodes & Scheeres 2004). Therefore efforts to improve workplace learning will usually impact unevenly across workplaces and individual workers. It would thus seem that we need to accept this as a cultural reality, not as a counsel of despair (Hodkinson et. al. 2004). After all, this is the issue that leads back to the question of who actually benefits from the learning taking place in the workplace (see Moilanen 2004).

Challenges for workplace learning and guidance in vocational education. Another question arising from the present study is whether we should accept

the idea that professional development needs time and various contexts which are not available in formal education environments alone. Former work experience, thus, has an essential role in building professional or vocational expertise, and without subjective experience it will not be possible to grow as a competent professional. Varying and accumulating experiences also help individuals to construct diversified views of different work communities, situations and tasks, and help them to learn how to manage in those situations. It can also be stated that in vocational education we learn the basics of a given vocation's technical requirements, knowledge and competencies. At work they are used and further developed. In addition to the technical competencies required in the practice of different vocations, we learn something else, such as recognizing ourselves as employees and workers and how to keep up in everyday social and communal interaction.

The role of social interaction and opportunities to participate in various tasks and social networks has been reported to be important by students in their workplace learning (see Fuller & Unwin 2003; Väisänen 2003). The need to investigate the differences and similarities, as regards collaboration and the construction of meaning, between formal and informal learning environments, has been noticed before (see Tynjälä, Välimaa & Sarja 2003). Consequently, on the basis of the findings of the present study, it is suggested that more supportive and participative elements should be included in formal workplace learning practices so that the communal could become as important an aspect of schools' cultures as it is a natural part of workplace practices.

Another way of improving vocational practices related to learning in the workplace would be the use of various work-based learning procedures which have already been developed around the world. WBL may take place in a variety of forms, such as in working life-oriented projects (see Tynjälä & Tourunen 2002), excursions, and an alternating sequence of placements or part-time employment. However this kind of learning is conducted, it is important that learning contracts and programme contents are negotiated by three partners: students, employers and vocational institutions, and that the implementation of such learning is based on real-time and work-based, authentic projects (see Tynjälä et. al. 2003). On the bases of the present findings, a promising direction for such projects would be to analyse work done in relation to what has been learned in the school environment. Such analytical learning tasks, connected to learning diaries, may provide an opportunity to critically evaluate one's learning in authentic working environments. Fruitful co-operation, in turn, can be ensured by further developing a functional relationship between education and working life.

Given that learning at work can be approached as a multifaceted phenomenon, including various processes in which the social and individual aspects are interdependent, it may be concluded that these aspects should be better taken into account also in vocational education in general. This is especially important because the public discourse about training in general has been criticised (see Eraut 2004), not only for neglecting informal learning, but for denying complexity by over-simplifying the processes and outcomes of

learning and the factors that give rise to it. Working contexts, for instance, can be so varied, that it may be possible that individual learning may be totally impossible in one context while in other it can be a successful experience both for the student and for the organisation.

Another recent study (see Virtanen, Tynjälä & Valkonen 2004, 77–82) shows how success in workplace learning, evaluated by the students themselves, is dependent both on elements related to the student him or herself and on the circumstances of the workplace. Although motivational factors, among others, were important in how far students felt that they had succeeded in their learning, positive experiences of how they were treated as equals in organisational participation also had an essential role in their enjoyment of their stay and of their learning at work. Thus it seems evident that providing students with the possibility to practice in many different organisational and vocational contexts during their vocational education would be one way of encouraging successful workplace learning during this life phase.

YHTEENVETO

Suunnitteluinsinöörien työssä oppiminen – kokemuksellisuutta ja jaettuja käytäntöjä

Johdanto ja tutkimuksen tarkoitus

Tämän tutkimuksen kohteena on suunnitteluinsinöörien ja tuotekehittäjien työssä oppiminen. Väitöskirjatyö koostuu yhteenveto-osasta ja viidestä englanninkielisestä artikkelista, jotka on julkaistu vuosina 2002–2005.

Tutkimuskysymysten taustalla vaikuttaa yleisempi yhteiskunnallinen muutos kohti tieto- ja oppimisyhteiskuntaa, mikä haastaa organisaatioita ja työntekijöitä järjestämään työnsä uudella tavalla. Työssä oppimisen ilmiö kiinnostaa yhä enemmän yrityksiä ja työnantajia, ammatillisen koulutuksen parissa toimivia, henkilöstön kehittämisestä vastuussa olevia kuin myös yhteiskuntaa laajemminkin. Kiinnostuksen motiivit vaihtelevat kuitenkin tarkastelijan mukaan: yksittäisen työntekijän näkökulmasta työssä oppimisen funktio liittyy oman osaamisen kehittymiseen ja uralla etenemiseen, kun taas yrityksissä ja organisaatioissa ollaan enemmän kiinnostuneita työssä oppimisesta, joka voi lisätä yrityksen tuottavuutta ja sitä kautta parantaa sen kilpailukykyä. Tässä tutkimuksessa työssä oppimista tarkastellaan työntekijöiden (erityisesti suunnitteluinsinöörien) itsensä kuvaamana ja kokemana. Lisäksi pyritään kuvaamaan ja ymmärtämään, miten oppiminen kiinnittyy työhön itseensä ja työkäytäntöjen sosiaalisiin prosesseihin.

Vaikka työssä oppimisen tutkimus on merkittävästi lisääntynyt viime vuosina, voidaan sitä edelleen pitää moniselitteisenä ja haastavana tutkimuksen kohteena. Tutkimuskenttä kärsii muun muassa yksiselitteisen käsitteistön puuttumisesta ja teorian kehittämisen keskeneräisyydestä. Erilaisista teoreettisista lähtökohdista ja kirjavasta käsitteistöstä huolimatta voidaan kuitenkin hahmottaa joitain työssä oppimisen keskeisiä piirteitä. Työssä oppimista luonnehditaan ensinnäkin informaaliksi, satunnaiseksi ja tilannesidonnaiseksi, eli oppimista ja työtä on vaikea erottaa toisistaan työn nopeasti muuttuvissa tilanteissa. Toiseksi, aikaisemmilla työkokemuksilla näyttää olevan perustavanlaatuinen merkitys työlle ja oppimiselle. Kolmanneksi, työtehtävät ja työn konteksti määrittävät, mitä työssä opitaan ja voidaan oppia. Lisäksi työssä oppiminen tapahtuu usein yhdessä kollegojen ja muiden työhön kiinteästi kytkeytyvien verkostojen kanssa.

Tutkimuksen kohteena olevaa suunnittelu- ja kehittämistyötä on aikaisemmin kuvattu lineaarisena ja yksilöllisenä ongelmanratkaisuprosessina, jossa työtehtävän ulkopuolisilla tekijöillä on vähäinen rooli. Nykytutkimus korostaa aikaisemmasta käsityksestä poiketen, että suunnitteluprosesseja ei ole helppo kuvata selkeärajaisiksi ja yleistä ongelmanratkaisuproseduuria noudattaviksi tapahtumasarjoiksi. Ne ovat pikemminkin epämääräisiä työkäytäntöjä, jotka sisältävät ennakoimattomia ja jatkuvasti muuntuvia elementtejä. Suunnittelutyötä luonnehditaan tutkimusten mukaan yhä enemmän tiimin tai työryh-

män kuin yksittäisen työntekijän ponnistukseksi. Työ tapahtuu usein moniammatillisissa ja vaihtuvissa työryhmissä, jolloin laajemmat organisatoriset kontekstit on otettava huomioon työtehtävien ja projektien menestyksellisessä loppuunsaattamisessa. Lisäksi moderneissa suunnitteluprosesseissa pyritään yhä useammin huomioimaan tuotteen tulevien käyttäjien näkemykset ja tarpeet jo suunnitteluvaiheessa. Osallistava suunnittelu on siis arkipäivää monissa organisaatioissa. Suunnittelutyökin nähdään edellä mainittujen ominaisuuksien lisäksi vaativana, uutta luovana ja innovatiivisena toimintana, joka edellyttää jatkuvaa oppimista ja kehittymistä.

Tämä tutkimus tarkastelee aineistolähtöisesti, millaisena suunnittelutyön arki ja siinä oppiminen näyttäytyvät ja millaisia merkityksiä työntekijät itse omalle toiminnalleen ja oppimiselleen antavat. Tässä tutkimuksessa kysyttiin, miten työntekijät itse määrittelevät työtään ja oppimistaan suunnittelutyön aikana ja sen kautta. Tutkimuksen tehtävänä on kuvata ja ymmärtää, millaisia käsityksiä suunnittelijoilla itsellään on työstään ja siinä oppimisestaan, millainen rooli aikaisemmilla työkokemuksilla on heidän työssä oppimisessaan ja miten työssä oppimista tapahtuu työn alati muuttuvissa ja uudelleen jäsentyvissä, jaetuissa käytännöissä.

Metodit

Työssä oppimisen moniselitteisen ilmiön tutkiminen ja asetettuun tutkimustehtävään vastaaminen edellyttivät useiden aineistonhankinta- ja analyysitapojen yhdistämistä. Tutkimus kohdistui toisaalta suunnitteluinsinöörien omiin käsityksiin työssä oppimisestaan ja heidän näkemyksiinsä aikaisemman työkokemuksen merkityksestä ja toisaalta siihen, millaisina työn tekemisen arki ja yhdessä toimiminen näyttäytyvät oppimisen näkökulmasta. Laajemmaksi menetelmälliseksi viitekehykseksi valittiin etnografia, jonka sisällä erilaisia aineistonhankinta- ja analyysitapoja käytettiin toisiaan täydentävästi. Suunnittelijoiden näkemyksiä ja kokemuksia heidän omasta oppimisestaan kartoitettiin haastattelujen ja tutkimuskysymyksiin soveltuvien analyysimenetelmien, fenomenografisen ja narratiivisen analyysin, avulla. Jaettuja käytäntöjä tarkasteltiin observointien ja etnografisen analyysimenetelmän avulla.

Tutkimuksen kohdejoukon muodostivat tuotesuunnittelun ja kehittämisen parissa työskentelevät insinöörit. Tutkittavat valittiin kahdesta high tech -yritykseksi luonnehdittavasta organisaatiosta Keski-Suomesta ja he olivat omissa työryhmissään vastuussa tuotesuunnittelusta ja -kehittämisestä. Toisessa, tutkimuksessa mukana olevassa yrityksessä suunnitellaan ja valmistetaan teollisuuden kalusteita ja työpisteitä, toisessa kehitetään tuotteita ja kokonaisvaltaisia ratkaisuja elektroniikkateollisuuden tarpeisiin. Kohdejoukon työntekijöiden taustakoulutus vaihteli ammatillisesta koulutuksesta yliopistopohjaisee ja työkokemus vaihteli muutamasta kuukaudesta useampaan kymmeneen vuoteen.

Aineiston hankinta tapahtui observoimalla työntekijöitä kahdessa suunnitteluorganisaatiossa 5–6 viikon ajan. Observointeja täydennettiin haastatteluilla. Aineisto hankittiin kahdessa vaiheessa, vuoden 2000 keväällä ja syksyllä. Aineistonhankinta eteni siten, että työntekijöitä havainnoitiin ensin mahdolli-

simman laajan ja syvällisen työkäytäntöjä koskevan konteksti- ja prosessitiedon saamiseksi. Havainnointijakson jälkeen yhteensä 18 suunnittelijaa pyydettiin haastateltavaksi.

Observointien ja haastattelujen analysointi aloitettiin kartoittamalla suunnittelijoiden näkemyksiä omasta työssä oppimisestaan. Aineistoa tarkasteltiin fenomenografisen analyysin avulla (ks. artikkeli I). Fenomenografinen analyysi tuotti yhteensä kuusi kuvauskategoriaa suunnittelijoiden käsityksistä työssä oppimisestaan. Näistä kategorioista valittiin suunnittelijoiden oman arvion perusteella keskeisimmät teemat jatkoanalyysien kohteeksi. Seuraavassa vaiheessa aikaisempien työkokemusten merkitystä työssä oppimiselle tarkasteltiin narratiivisen analyysin avulla (ks. artikkeli II). Etnografisen analyysin avulla pureuduttiin työkäytäntöjen sosiaalisiin ja jaettuihin prosesseihin (artikkelit III ja IV). Lisäksi analysoitiin työntekijöiden näkemyksiä formaalissa koulutuksessa saadun opin ja työn käytännöissä omaksutun tiedon välisestä suhteesta (artikkeli V).

Tulokset ja johtopäätökset

Tutkimuksen tavoitteena oli kuvata ja ymmärtää suunnittelutyössä tapahtuvaa oppimista työntekijöiden itsensä kokemana. Lisäksi tarkoituksena oli kuvata suunnittelutyön arkea ja siinä tapahtuvaa oppimista. Tutkimus osoitti edetessään, että ilmiön yksiselitteinen määritteleminen ja käsitteellistäminen ovat haastavia tehtäviä ja vaativat edelleen jatkotutkimusta.

Analysoinnin ensimmäisessä vaiheessa toteutettu fenomenografinen analyysi (artikkeli I) osoitti työssä oppimisen moni-ilmeisyyden. Se tuotti kuusi erilaista tapaa käsittää työssä oppimista. Työhön kytkeytyvä oppiminen nähtiin vahvasti työhön itseensä kiinnittyväksi toiminnaksi ja jatkuvaksi kollegojen kanssa yhdessä toimimiseksi. Lisäksi aikaisemmilla työkokemuksilla nähtiin olevan monella tavalla merkittävä rooli työssä oppimiselle, vaikka suunnittelutyön kautta oppimisen koettiinkin edellyttävän myös aivan uudenlaisten ja tuntemattomien asioiden luovaa haltuunottoa. Myös formaalilla koulutuksella ja moninaisilla työpaikan ulkopuolella olevilla konteksteilla ja tahoilla oli suunnittelijoiden mukaan merkittävä rooli oppimisessa.

Kun aikaisempien työkokemusten roolia lähdettiin tutkimaan tarkemmin narratiivisen analyysin avulla (artikkeli II), havaittiin kokemusten olevan tärkeitä jokapäiväisten sosiaalisten suhteiden hoidossa. Työssä tapahtuva sosiaalinen vuorovaikutus eri tasoilla on samalla sekä työssä oppimisen väline että oppimisen kohde. Työntekijät olivat sitä mieltä, että kokemalla oppiminen on ainoa tapa oppia toimimaan erilaisten ihmisten kanssa vaihtelevissa ja muuttuvissa työtilanteissa. Kokemuksilla on myös merkittävä rooli sekä kokenemmille että kokemattomammille työntekijöille hahmotettaessa ja analysoitaessa työprosesseja. Suunnittelijat korostivat, että myös kollegan kokemus työhön liittyvästä tapahtumasta tai ihmisestä voi olla opettavainen kokemus. Ennen kaikkea työuran aikana kertyneen kokemuksen kautta työntekijät pystyvät luomaan omanlaisen käsityksen tai teknisen näkemyksen siitä, mikä suunnittelutyössä on tärkeää.

Etnografisella analyysillä pureuduttiin tarkemmin suunnittelijoiden työssä tapahtuvaan sosiaaliseen vuorovaikutukseen ja jaettuihin käytäntöihin (artikkelit III ja IV). Suunnittelutyössä oppimista voidaan luonnehtia neljän teemaattisen havainnon avulla. Ensinnäkin yhteisöllisyyden tunteen ja hyvän ilmapiirin ylläpitäminen näyttäytyi tärkeäksi työn arjessa ja siitä oppimisessa. Yhteisöllisyyden tunteen ylläpito edellyttää jatkuvaa ponnistelua, esimerkiksi huumorin, ja toisten työntekijöiden tai asioiden tyypittelyn avulla. Tällainen tyypittely ja vitsailu auttavat myös työntekijöitä asemoimaan itsensä osaksi työyhteisöä ja rakentamaan ammatillista identiteettiään. Toiseksi etnografinen analyysi paljasti työkäytäntöjen olevan jatkuvassa liikkeessä ja muutoksessa. Työtehtäviä ja tavoitteita joudutaan tilanteen mukaan tulkitsemaan uudelleen ja mahdollisista ratkaisuista neuvottelemaan aina erikseen toimintaympäristöistä tulevien haasteiden edellyttämällä tavalla. Jatkuva muutos näyttää edellyttävän myös jatkuvaa oppimista muuntuvien tavoitteiden saavuttamiseksi. Kolmanneksi, jaetut käytännöt eivät konstituoituneet ongelmattomasti, vaan tiimien yhteinen työskentely sisälsi myös konflikteja ja erimielisyyttä, joka kuitenkin parhaimmillaan toi tiimin jäseniä yhteen ja rakensi edelleen tiimin toimivaa ilmapiiriä. Neljänneksi, tutkimuksen kohteena olevia työpaikkoja näytti luonnehtivan jatkuva työkäytäntöjen jakaminen ja ongelmanratkaisu mitä erilaisimpien tiimien, työryhmien ja verkostojen kanssa sekä työorganisaatioiden sisällä että niiden ulkopuolella. Jatkuvasti muuntuvien ongelmien ratkaisun edellytyksenä näyttivät olevan neuvottelu ja kompromissien tekeminen. Suunnittelijat korostivat käsillä olevan työtehtävän tai ongelman mahdollisimman kokonaisvaltaista hahmottamista eri tahojen kanssa. Tutkimustulosten perusteella näyttää, että ainakaan suunnittelutyössä ongelmanratkaisu ei näyttäydy lineaarisena prosessina, vaan kulloinkin vastaan tuleva ongelmallinen tilanne edellyttää tilanteeseen ja ongelman luonteeseen kytkeytynyttä jaettua toimintaa.

Tutkimuksessa tarkasteltiin syvemmin myös suunnittelijoiden käsityksiä työssä ja koulutuksessa tapahtuvasta oppimisesta ja niiden suhteesta (artikkeli V). Koulutuksesta omaksutun teoreettisemman tiedon ja työpaikalla tarvittavan käytännön osaamisen suhde näyttäytyi suunnittelijoille kolmella tavalla. Ensinnäkin niiden suhde nähtiin jatkumona. Työelämässä tarvittavat työvälineet ja perustaidot opitaan koulutuksessa, mutta työelämässä selviäminen edellyttää myös jatkuvaa oppimista. Toiseksi, koulusta saadun tiedon koettiin korvautuvan myöhemmin työelämässä saadulla opilla. Kolmanneksi nähtiin, että teoriaa ja käytäntöä kumpaakin tarvitaan tyelämässä ja että ne muodostavat yhtenäisen kokonaisuuden, jossa teoreettiset ja käytännölliset elementit luontevasti sulautuvat. Suunnittelijat kokivat työelämän ja koulutuksen kuitenkin erilaisina oppimiskonteksteina, joiden tavoitekin on erilainen. Työssä tavoite on autenttisista työtehtävistä selviytyminen ja koulussa kokeiden läpäiseminen.

Edellä kuvattujen tulosten pohjalta suunnittelutyötä ja siinä oppimista määritteltiin uudelleen: 1) Suunnittelutyön käytännössä oppimista ja työntekoa ei voida erottaa toisistaan. Työ itsessään sisältää oppimista. 2) Formaalin koulutuksen kautta saatua ja työssä omaksuttua oppia ei ole tarpeen erottaa toisistaan suunnittelijan työssä. 3) Aikaisemmilla työkokemuksilla on keskeinen rooli suunnittelutyössä oppimisessa. 4) Suunnittelutyön käytännöt ovat jaettuja, ver-

kottuneita ja tilannesidonnaisia. Työtehtäviä ei voi irrottaa siitä kontekstista, jossa ne tapahtuvat.

Yleisemmän tason johtopäätöksinä tulosten perusteella voidaan todeta, että työssä oppimisen ilmiön kuvaamista pelkästään formaalin koulutuksen käsitteillä voidaan kritisoida. Formaalin koulutuksen ja oppimisen käsitteillä ei pystytä esimerkiksi tavoittamaan työssä oppimisen ilmiön moninaisuutta. Työssä oppimisen luonnetta ei voida tavoittaa myöskään kuvaamalla sitä ainoastaan informaaliksi. Monia työssä oppimisen prosesseja on jo pystytty paljastamaan tutkimuksen avulla. Lisäksi työssä oppimisen yksilölliset ja sosiaaliset aspektit tulisi nähdä yhteenkietoutuneina ja ilmiön erottamattomina osina. Tämän tutkimuksen tulokset osoittavat, että yksittäisen työntekijän kokemukset ja moninaiset sosiaalisen ja jaetun oppimisen aspektit ovat työkäytännöissä läsnä samanaikaisesti.

Jatkotutkimushaasteet ja käytännön implikaatiot

Työssä oppimisen moniselitteisyyden vuoksi käytännön johtopäätöksiä ja jatkotutkimusta tarvitsevia teemoja on aiheellista tarkastella yhdessä. Tutkimukseni perusteella ei ole mahdollista tehdä pitkälle yleistettäviä johtopäätöksiä. Siksi käytännölliset ja tutkimukselliset johtopäätökset on hyvä nähdä alustavina ehdotuksina lupaavista jatkotarkastelun suunnista ja käytännön sovellutuksista Tulosten perusteella voidaan kuitenkin osoittaa, että käytännön johtopäätöksiä voidaan tehdä moneen eri suuntaan. Ensinnäkin, kun suunnittelutyö nähdään luonteeltaan sekä teknisenä että sosiaalisena, yhteistyön merkitystä yhä laajenevissa verkostoissa tulisi tutkia tarkemmin. Lisäksi yhteistyötä ja yksilöllisesti kertynyttä näkemyksellisyyttä tulisi tutkimuksissa tarkastella yhtä aikaa. Suunnittelijoiden koulutuksessa nämä seikat tulisi huomioida aikaisempaa huolellisemmin, jos koulutuksen tavoitteena on valmistaa työelämään innovatiivisia, riskinottokykyisiä ja tehokkaaseen tiimityöhön kykeneviä suunnittelijoita.

Toiseksi, tarkasteltaessa työssä oppimista yleisemmällä tasolla ohjaamisen kysymykset nousevat keskeisiksi. Tämän tutkimuksen tulokset osoittavat, että työssä oppimista tapahtuu parhaimmillaan silloin, kun yksittäisen työntekijän aikaisempi kokemus, työhön liittyvät tavoitteet ja ohjaustarpeet pystytään huomioimaan tilannekohtaisesti. Jotta työprosesien ja oppimisen ohjausta voitaisiin kehittää, työtehtäviä ja -prosesseja tulisi analysoida jatkuvasti ja johdon tulisi tukea tätä toimintaa. On kuitenkin muistettava, että organisaatioissa tapahtuu jatkuvasti myös sellaista oppimista, joka ei edistä organisaation tavoitteita. Esimerkiksi työnantajan järjestämä koulutus ei johda toivottuihin tuloksiin jokaisen työntekijän ja työntekijäryhmän kohdalla. Eräs jatkotutkimuksen aihe voisi siten olla, millaisia piirteitä avoimella ja kaikkien oppimista palvelevalla työympäristöllä tulisi olla.

Työssä oppimisen prosessien ymmärtäminen voi auttaa myös kehittämään ammatillisessa koulutuksessa toteutettavan työssäoppimisen ohjausta. Tämän tutkimuksen tulosten myötä on perusteltua väittää, että työntekijöiden itsensä näkökulmasta työ ja koulutus näyttäytyvät hyvin erilaisina oppimisen konteksteina. Työtoiminta ja sen kautta tapahtuva oppiminen koettiin ”oikeak-

si", työn todellisten ongelmatilanteiden ohjaamaksi toiminnaksi. Siksi formaalin koulutuksen ja työssä oppimisen integrointi tulevaisuudessa on yhä tärkeämpää. Eri alojen ammattilaisten koulutuksen järjestämisessä tulisi huomioida, että työssäoppimisjaksot tulisi sisältää enemmän osallistavia ja oppimista tukevia käytäntöjä siten, että työpaikkojen luonnollinen yhteisöllisyys voisi olla myös koulutuksen luonteva osa.

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APPENDIX 1 Themes for interviews

1. Tell me about your job
- What comes to your mind first if I ask you to tell me about something that has happened to you at work? A specific situation perhaps?
- What kind of work would you describe as your normal work? What does your normal work involve?
- How far do you feel that the project-based work or development work differs from the work you would describe as your everyday or normal work?
- Do you feel that your work keeps you harried?

The researcher: "I have been observing this organization, its workers and its functioning as a whole for a few weeks now and I have been able to create some kind of a picture of it. However, now I would like you to tell me about your job and those aspects of it which you feel are important.

2. What do you think you have to be able to do in your work? What kinds of competencies related to your job do you have?
- What do you feel that you can handle or do better now than 1/5/10 years ago? Why?
- What do you think that you would need to do better in the future? What do you suppose you will be able to do better in the future? What are the competencies which you would like to develop further?
- How and where are these competencies acquired? How have you learned them?
- Is it possible to separate theory and practice in your competence? How are these elements represented in your competence?
- In your opinion, do you posses a specific kind competence which nobody else in this organization possesses? What kind of competence is it?

3. What do you think about your job and about this work community after 1/3/10 years?
- How would you describe your work community?
- How important are you for this organization as an employee? What is your place as a part of the larger entity?
- What would you best remember about this community if you had to leave it now?

4. Describe your relationships with colleagues and the networks outside this organization.
- Who do you have to keep in touch with daily/weekly/monthly?
- Who are the most important people for you from the point of view of your job?
- Describe an ideal colleague? What can you learn from him/her? Why do you think so?
- Do you prefer working alone, with colleagues, or together within a group or team? Why?

5. Challenging situations at work.
- Describe a nightmare-like situation(s) which you have had to deal with at work. How did you manage?
- Why was this specific situation challenging for you?
- How did you cope with the situation?
- What happened the next time you faced a similar kind of situation? (What was learned?)
- What was the solution or coping with the situation based on?

6. Learning at work.
- How demanding would you judge your job to be? Do you think that within a specific time limit you would be able to learn to master your job as well as far as it can be mastered? Why? Why not?
- What kinds of situations at work have forced you to think radically differently about something? How have your opinions changed as a result of this?
- What kinds of significant learning experiences can you find in your career to take? Why were these experiences meaningful for your learning? How other people are connected to these experiences or are they not? How are other people connected to your learning experience?
- What makes tan easy problem-solving situation a learning situation? What makes difficult communication situations learning situations?
- Where do the most inspiring and the most innovative ideas for your work come from?
- What kinds of issues is your learning and development dependent on? (Is it dependent, for instance, on your own learning potential and motivation, or the possibilities which this organization provides for you to learn?)
- Does this organization and team make continuous learning possible for you?
- Describe specific work situations a little more (= situations where both the researcher and the designer have been present, for example, team meetings, negotiations with colleagues etc.). How did you learn within these situations? What was the learning outcome for you and for other designers?