Helsinki University of Technology Laboratory of Work Psychology and Leadership Report 2005/1 Espoo 2005

# KNOWLEDGE CONVERSIONS IN KNOWLEDGE WORK - A DESCRIPTIVE CASE STUDY

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ISBN 951-22-7586-4 (print) ISBN 951-22-7587-2 (electronic) ISSN 1459-8035 (print)

Monikko Oy Espoo 2005

#### Abstract

Knowledge creation is considered as an invaluable asset of companies to survive in the highly competitive global market. However, only a few researchers have articulated how organizations actually create knowledge. Nonaka and his colleagues make an exception to this their model being widely cited and utilized as a framework in many articles and studies. The aim of this study was to examine how the model of Nonaka is realized in three types of knowledge work: whether all the knowledge conversions can be identified in knowledge work, how these conversions are emphasized and what are the methods for accomplishing these conversions. The aim of the report is two-fold: first, it provides further understanding of the knowledge processes (knowledge conversions) leading to knowledge creation in organizations, and second, it examines, comments and complements the model of Nonaka et al. in relation to knowledge work.

A basic assumption in the model of Nonaka et al. is that knowledge creation is interaction between tacit and explicit knowledge which takes place through four different knowledge conversions: socialization (sharing tacit knowledge), externalization (converting tacit knowledge to explicit), combination (combining explicit knowledge) and internalization (converting explicit knowledge to tacit). These knowledge conversions build up into a spiral continuing from individual to organizational level. In this study, these knowledge conversions were studied in software design, software research and real estate strategy and process development work. The focus of analysis was on individual and group level. The research approach was qualitative case study, and research methods used were individual and group interviews and observation. The data were analyzed using content analysis.

In light of the results of the study, the emphasis of different knowledge conversions seems to be depending on the contents of the knowledge work and hence on the kind of knowledge work at issue. However, the ways of carrying out the knowledge conversions seem to be more dependent on other factors like team vs. individual work, working culture, workspace arrangements and other organisational enablers than the kind of knowledge work at hand. The greatest differences between the theory presented by Nonaka et al. and the results of the study were in the context – 'ba' – in which the knowledge conversions took place.

## Foreword

This report is based on the licentiate thesis of the author the instructors of which were professor Eila Järvenpää and D.Sc. (Tech.) Stina Immonen, the supervisor professor Eila Järvenpää and the examiner professor Riitta Smeds. The data of this study were gathered in an 'Innovation and Place' project. The aim of the project was to examine whether the physical workplace settings can enhance innovation and knowledge work. The project was initiated and coordinated by project manager and architect Marja Kauttu.

The financing of the project was derived from Tekes (Technology Agency of Finland) and the participating companies. Financial support for writing the licentiate thesis was received from Työsuojelurahasto (The Finnish Work Environment Fund).

Espoo March 2005

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# 1. Introduction

Human beings and their physical and mental qualities have not changed much throughout the centuries or even millennia but the environment they live in has. As humans are a curious race and able to utilize tools and innovate, they seem to be capable of transforming their environment quicker than they change themselves. In consequence, the long era of agricultural age has been transformed into shorter era of industrial age while at the moment we are living already the third wave, information age (Toffler, 1983). Characteristic of the third wave is that wealth and prosperity is no longer due to possession of land or capital, but possession of knowledge and the capacity to create and utilize it (Prahaland and Hamel, 1990; Nonaka and Takeuchi, 1995; Kogut and Zander, 1996; Spender, 1996; Nahapiet and Ghoshal, 1998).

In consequence of the radical changes due to the information age and the development of new technologies resulting in the globalization of business, the evolution of knowledge economy, increased competition on markets and shorter lifecycle of products, telework and networking in the cyberspace (Forster, 2000) some authors have claimed that organizations are going to be superseded by self-organizing systems and the era of organizations is coming to its end (see Brown and Duguid, 1998). However, this forecast may not come true as the organizations are claimed to have a future as they provide important means for knowledge creation (Brown and Duguid, 1998). Knowledge creation is not merely an individual or virtual activity but resides in social networks and communities of practice (Brown and Duguid, 1998; Turvani, 2001).

Knowledge creation has become a key factor of organizations as the pressure of companies to constantly create new knowledge to renew and innovate has grown invincible in this third wave era. The field of knowledge management has emerged to tackle the issues of management of knowledge and information as well as knowledge creation. Knowledge management from the perspective of this study can be defined as the capacity of organizations to develop their organizational performance by improving the use of employee skills, experience and knowledge (Pan and Scarbrough, 1999).

However, despite vivid discussion on knowledge and knowledge creation among both academics and practitioners in the area of knowledge management, only a few have articulated

how organizations actually create knowledge (Pan and Scarbrough, 1999; Nonaka, Konno and Toyama, 2001). Furthermore, understanding the dynamics of knowledge work as compared to the earlier forms of work is still in its infancy (Drucker, 1999; Scarbrough, 1999). While we are living in the information age, prevailing theories of organizations and the way how companies and even people function are still to a great extent from the industrial age (Christopher, 1998).

Knowledge creation in this study is defined as interaction between tacit and explicit knowledge which takes place through four different knowledge conversions (Nonaka, 1994). The aim of this study is to increase the understanding of the knowledge conversions in knowledge work in order to improve the comprehension of the knowledge creation processes in knowledge work. Furthermore, the implications of these conversions on transforming individual knowledge to organizational knowledge of companies will be discussed.

For this purpose, the knowledge conversions embedded in knowledge creation are studied in four cases representing software development, software research and real estate strategy and development work. The model represented by Nonaka et al. (Nonaka, 1994; Nonaka and Takeuchi, 1995; Nonaka and Konno, 1998) is used as a framework for analyzing the knowledge conversion processes. A basic assumption in the model is that knowledge creation is interaction between tacit and explicit knowledge which takes place through four different knowledge conversions: socialization (sharing tacit knowledge), externalization (converting tacit knowledge to explicit), combination (combining explicit knowledge) and internalization (converting explicit knowledge to tacit). Knowledge sharing builds up an inherent part of these conversions. The knowledge conversions build up into a spiral continuing from individual to organizational level.

In this study, the model developed by Nonaka et al. (Nonaka, 1991; 1994; Nonaka and Takeuchi, 1995; Nonaka and Konno, 1998; Nonaka, Toyama and Konno, 2000; Nonaka, Toyama and Nagata, 2000) is systematically applied into knowledge work and the knowledge conversions embedded in the knowledge creation in knowledge work will be examined. The results of the study will hopefully be applicable for academics tackling the human aspects of knowledge management and especially knowledge creation as well as for managers by helping

to support working practices that would lead to the necessary knowledge creation in their organization enabling the company to renew and innovate.

# 1.1 Defining knowledge work

#### 1.1.1 Knowledge

In the third wave era (Toffler, 1983), the management of knowledge has become a key issue in keeping track of the competition in business (Hope and Hope, 1997). The landscape of knowledge management is extended wide ranging from technological applications to management of knowledge assets and methodologies all the way to providing environments enhancing the knowledge creation of knowledge workers (Binney, 2001). In this study, the focus is on this latter aspect of knowledge management. Knowledge management in this study is defined as the capacity or processes within an organization to maintain or improve organizational performance based on experience and knowledge (Pan and Scarbrough, 1999). It involves the way organizations build, supplement and organize knowledge and routines around their activities as well as in their culture by e.g. improving the skills of their employees (Pan and Scarbrough, 1999).

In this study, knowledge is divided into two types: explicit and tacit (Polanyi, 1966; ref. Nonaka, 1994). Knowledge is typically not only explicit or tacit but involves both. Explicit knowledge is knowledge that is expressed in formal language. It can be shared in the form of documents, manuals, specifications and the like. Tacit knowledge is know-how that is difficult or even impossible to express in words. It is personal and tied to people like subjective insights, intuitions, and hunches. This makes it difficult to communicate and share. Tacit knowledge has both cognitive and technical elements (Nonaka, 1994). Cognitive elements are mental models through which individuals perceive and define their world. Technical elements of tacit knowledge, on the other hand, are the concrete know-how, crafts and skills an individual has. Tacit knowledge involves values, feelings and emotions of individuals, and forms the basis of trustful relationships (Nonaka and Konno, 1998). (Figure 1). Furthermore, Scharmer (2001) has suggested that there are two types of tacit knowledge: 1) embodied tacit knowledge that is

based on one's experience, and 2) self-transcending knowledge that is tacit knowledge prior to its embodiment in day-to-day practices – knowledge enabling to invent e.g. new ideas and practices.



Figure 1. Two types of knowledge: tacit and explicit (based on Nonaka, 1994).

Knowledge has also been classified into other kinds of categories (Collins, 1993; Blackler, 1995; Millar, Demaid and Quintas, 1997; Blumentritt and Johnston, 1999). Blackler (1995) has summarized the categories presented in the literature into embrained, embodied, encultured, embedded and encoded knowledge. Embrained knowledge relates to the conceptual skills and cognitive abilities of individuals. Embodied knowledge, on the other hand, is action oriented and is rooted in specific contexts. Encultured knowledge "refers to the process of achieving shared understanding" (Blackler, 1995, p. 1024) and embedded knowledge is "knowledge which resides in systemic routines" (Blackler, 1995, p. 1024). Encoded knowledge is "information conveyed by signs and symbols" (Blackler, 1995, p. 1025). Lam (2000) considers embrained knowledge (Figure 2). Furthermore, Lam (2000) suggests that embodied knowledge represents individual tacit knowledge and embedded knowledge collective tacit knowledge. Lam (2000) has combined the two categories of encultured and embedded knowledge into one category of embedded knowledge. Encultured knowledge has many of the

cognitive elements of tacit knowledge whilst embedded knowledge has similar qualities as the technical elements of tacit knowledge like does the embodied knowledge as well. However, also embrained knowledge has similarities with the cognitive elements of tacit knowledge even though it is categorized as explicit-individual knowledge in Lam's classification.



Figure 2. Categorization of different types of knowledge (Lam, 2000).

Knowledge, especially in knowledge management literature, is often used interchangeable with information (Blumentritt and Johnston, 1999). In many companies 'knowledge managers' are usually the ones responsible for improving the information systems of a company and accordingly for information management. However, a distinction can be made between data, information and knowledge. Data are defined as simple observations, information as data endowed with relevance and purpose, and knowledge as valuable information from the human mind that includes reflection, synthesis and context (Davenport and Prusak, 1998). Dretske (1981) defines information and knowledge as follows: "Information is that commodity capable of yielding knowledge, and what information a signal carries is what we can learn from it (Dretske 1981, p. 44). Knowledge is identified with information-produced (or sustained) belief, but the information a person receives is relative to what he or she already knows about the possibilities at the source (ibid, p. 86)." The link between information, knowledge and utilization of information systems is suggested by Blumentritt and Johnston (1995, p. 293) as follows: "If knowledge has to be translated back into information to be transferred between two intelligent systems, to be then absorbed and translated back to knowledge, information

management plays a role in the dissemination of information but is not a distributor of knowledge."

In this study, both explicit and tacit knowledge are tied to the persons and their actions and accordingly the focus is on knowledge and not information. Knowledge is defined as justified true belief according to Platon's definition of knowledge adopted alike by Nonaka et al. (1994; 1995) in this study. The definition involves three assumptions: 1) one has to believe in the knowledge, 2) the knowledge has to correspond or be coherent with the reality, and 3) the knowledge has to be justified (Lammenranta, 1993). However, these assumptions cause some inconvenience when applied to tacit knowledge. Firstly, the tacit knowledge individuals have is not justified explicitly. Secondly, the individuals are not necessarily aware of their tacit knowledge and accordingly may not be said to be believing in it. Overall, knowledge by its definition in Platon's philosophy seems to be more sophisticated and logically justified than the more commonplace knowledge built up of e.g. experiences examined in this study. However, this definition emphasizes the constructivist approach of individuals creating meaning of the world instead of getting knowledge from objective reality (Sveiby, 2001).

#### 1.1.2 Knowledge work

As a result of the third wave, manufacturing jobs have and are continuing to decline agricultural jobs declining even more dramatically (Castells, 1996). The trend during past decades has been the shift from manual and operational work to knowledge work. According to Pyöriä (2001) the amount of knowledge work has increased from 12 % to 39 % during past thirteen years in Finland. The amount is even bigger in the review of Statistics Finland (Tilastokeskus 1997; 1999).

Related to the changes of work during past decades, Drucker (1988) has originated the term 'knowledge worker' to conceptualize these changes. According to Drucker (1999), continuing innovation and continuous learning and teaching are fundamental parts of knowledge work. The output of work is no longer measured in quantity but more importantly in quality. Knowledge workers, however, often do both manual and knowledge work – these form a group of

knowledge workers called 'technologists'. (Drucker, 1999). E.g. surgeons and engineers belong to this category.

Characteristic of knowledge work is that it is not defined by certain occupation but it covers a range of occupations. According to Scarbrough (1999, p. 7) "lacking the demarcations and controls of conventional professional groups, knowledge workers are defined primarily by the work they do – work which is relatively unstructured and organizationally contingent, and which thus reflects the changing demands of organizations more than occupationally-defined norms and practices."

Following, there is no prevailing definition of knowledge work but the concept is rather surrounded by confusion and ambiguity (Collins, 1997). Some researchers define knowledge work as being the property of narrow professional elite (Despres and Hiltrop, 1995; Kelley, 1990; Nomikos, 1989) while e.g. Drucker (1991, p. 71) sees that "knowledge and service workers range from research scientists and cardiac surgeons through draftswomen to store managers to 16 year olds who flip hamburgers in fast food restaurants on Saturday afternoons. Their ranks also include people whose work makes them "machine operators": dishwashers, janitors, data entry operators." Furthermore, Collins (1997, p. 45) points out that also more automated and physical jobs require some working knowledge – he claims that "no matter what we do we are all, in some form or other, knowledge workers".

However, knowledge work has been delimited in this study according to the definition suggested by Davenport, Järvenpää and Beers (1996, p. 54): "Knowledge work's primary activity is the acquisition, creation, packaging, or application of knowledge. Characterized by variety and exception rather than routine, it is performed by professional or technical workers with a high level of skill and expertise. Knowledge work processes include such activities as research and product development, advertising, education, and professional services like law, accounting, and consulting. We also include management processes such as strategy and planning." Thus, while many kinds of jobs involve use or application of knowledge, according to this definition knowledge work is one in which working with knowledge is the primary activity. The definition also excludes routine jobs which do not require high level of skill or expertise.

#### 1.1.3 Knowledge and organizations

As the definitions of knowledge work are broad and not limited to certain professional groups, one way to classify knowledge work is to differentiate certain types of knowledge work and organizations from each other. Knowledge work can be categorized by grouping it according to different types of knowledge that is emphasized in the work together with the type of organization it is executed in. For this purpose, knowledge can be divided into individual and collective explicit knowledge, and into individual and collective tacit knowledge. A basic assumption is that different kinds of organizations have diverse emphasis on the type of knowledge that is most essential for the company (Blackler, 1995; Hansen, Nohria and Tierney, 1999; Lam, 2000).

Lam (2000) has categorized organizations based on this classification of knowledge drawing upon Mintzberg's (1979) classic typology of organizational forms and the work of Aoki (1988) and Nonaka and Takeuchi (1995). She has distinguished professional bureaucracy with emphasis on individual-explicit (embrained) knowledge, machine bureaucracy with emphasis on collective-explicit (encoded) knowledge, operating adhocracy with emphasis on individual-tacit (embodied) knowledge, and J-form organization with emphasis on collective tacit (embedded) knowledge (Figure 3). In any kind of organization all of the four knowledge types are normally presented. However, the emphasis and importance of the knowledge types for the operations of the company differ across different kinds of organizations.

Knowledge	Individual	Collective	
Explicit	Professional bureaucracy	Machine	
	bureaucracy Organization		
Tacit	Operating adhocracy	J-form organization	

Figure 3. Knowledge and organizations (modified from Lam (2000)).

Professional bureaucracies are organizations in which the theoretical and abstract knowledge of highly trained individual experts is in crucial role. Knowledge and skills can be standardized and acquired through formal education and training. Hospitals and universities are examples of professional bureaucracies. Individual experts have high degree of autonomy in this kind of organizations even though the structure of the organization is bureaucratic. (Lam, 2000).

Starbuck (1992) has noted that professionals in the professional bureaucracies entail 'perceptual filters'. This means that the professionals easily interpret specific situations in terms of general problems and place new problems in old categories. Furthermore, the knowledge structure in this type of organizations is individualistic, functionally segmented and hierarchical. This causes problems in sharing and disseminating knowledge across functional boundaries. As there is not much redundancy of knowledge between highly specialized individual experts, the sharing of tacit knowledge is also damaged.

In machine bureaucracies, collective explicit knowledge is in key role. In this kind of organizations, the work is highly specialized, standardized and controlled. The competitive advantage is derived from efficiency and stability. The skill requirements of individual workers are usually low. Traditional factory is an example of this organization type. (Lam, 2000).

The knowledge of organization in machine bureaucracies is in written rules, procedures and performance standards. The knowledge structure is functionally segmented and hierarchical. The role of tacit knowledge is minimized which leads to partial, incomplete and impoverished knowledge. This organization type is able to deal only with routine problems, not with novelty or change. (Lam, 2000).

In operating adhocracies, on the other hand, individual tacit knowledge plays the major role. In this type of organizations there is little standardization of knowledge or work processes. The individual experts have high autonomy in their work which is based on their diverse know-how and problem-solving skills. Experimentation and interactive problem-solving are characteristic ways of working. (Lam, 2000).

Software engineering firms and management consultancies are examples of operating adhocracies. These are kind of 'know-how companies' providing non-standard, creative, problem-solving services directly to their clients (Sveiby and Lloyd, 1987). The knowledge in this kind of organizations is tied to the experts and learned by working, interacting and solving problems together. These kind of organizations are fluid, fast moving and innovative. However, the knowledge is not usually articulated and accumulated to the organization knowledge base but is lost if the expert leaves the company. The notion of 'knowledge intensive firms' adopted by Starbuck (1992; 1993) refers to operating adhocracies.

According to Blacker (1995) the trend has become and in near future will be a change towards the J-form organization. In this kind of organization collective tacit knowledge is critical being embedded in operating routines, team relationships and shared culture. This is the kind of knowledge-creating organization that has been illustrated by Nonaka and Takeuchi (1995). In this kind of hypertext organization the bureaucratic functional structure operates in parallel with organic, non-hierarchical team structure (Nonaka et al., 1995).

In J-form organizations the key knowledge is not knowledge of individuals but knowledge of cross-functional teams. Knowledge in J-form organizations becomes organizational as the experts return from the temporary teams to their formal positions. Knowledge is also stored in the operational routines and in the networks of human relations. (Lam, 2000).

Ståhle and Grönroos (2000) have defined a structure of knowledge-intensive organizations which resemble the J-form or hypertext organization. According to Ståhle and Grönroos (2000), knowledge-intensive organizations, to be successful, should be built of three different kinds of business environments: mechanical, organic and dynamic. In the mechanic environment, stable operations which require controlled quality are executed. In the organic environment, the processes are self-organizing and the role of tacit knowledge and dialogue are emphasized. The dynamic environment, on the other hand, is characterized by uncertainty, often chaotic flow of information, networking and intuitive knowledge which enable the company to renew and innovate. (Ståhle and Grönroos, 2000). There seems to be some differences between J-form organization with the bureaucratic functional structure operating in parallel with organic, non-hierarchical team structure (Nonaka, 1994) and the mechanic-organic-dynamic structure of a

knowledge-intensive organization (Ståhle and Grönroos, 2000): in the previous one the same employees switch between the two structures whereas in the latter one different functions typically belong to certain structure, like accounting to mechanic and development to dynamic structure.

# **1.2 Knowledge creation**

Fluid knowledge creation is considered as the perpetuating force of current and future firms (Brown and Duguid, 1998). The strategic role of knowledge creation to gain competitive advantage has been vividly discussed (e.g. Grant, 1996; Spender, 1996; Zack, 1999). From the strategic management point of view knowledge is usually seen as a stock which can be acquired or bought into the company e.g. by acquisitions and fusions (Davenport and Prusak, 1998) or employing certain types of specialists (Matusik and Hill, 1998), and is concerned with the skills and competencies of the employees (e.g. Zack, 1999; Sharkie, 2003). In this strategic context, the dynamic human processes leading to the economic outputs desired are rarely discussed (Scarbrough, 1999).

Another stream of literature has focused on the organizational enablers of knowledge creation. These authors have studied how knowledge creation in organizations is influenced by factors like care (von Krogh, 1998); knowledge activists or facilitators (von Krogh, Ichijo and Nonaka, 2000; Roth, 2003); knowledge vision, conversations, right context and globalizing local knowledge (von Krogh et al., 2000); social interaction (Chua, 2002); as well as culture, existing skills and competencies, organizational structures, leadership and the ability to change (Ingelgård, Roth, Shani and Styhre, 2002). While these studies have found many enablers of knowledge creation, a comprehensive model on the dynamics of knowledge creation has been introduced and developed by Nonaka and his colleagues (Nonaka, 1991; 1994; Nonaka et al., 1994; Nonaka and Takeuchi, 1995; Nonaka and Konno, 1998; Nonaka, Toyama and Konno, 2000; Nonaka, Toyama and Nagata, 2000). They have approached the knowledge creation process on individual, group and organizational levels.

The model of Nonaka et al. has been widely used as a framework for studying organizational knowledge creation. E.g. organizational enabling conditions influencing collective knowledge creation has been studied using the Nonaka's framework (Hustad, 1999) as well as knowledge creation of a small work group based on a knowledge base capturing the expertise of individuals and making it available to others (Salisbury, 2001) and the knowledge creation of multinational corporations (Kulkki, 1999).

The model of Nonaka et al. has been adopted as a framework for this study as the most comprehensive one describing the dynamic knowledge creation process, and being widely cited and utilized as a framework in other studies. Whilst the model has been applied to e.g. defining the enablers of knowledge creation in companies, it has not been systematically applied to everyday knowledge work to analyze the knowledge conversion processes in it.



Figure 4. Three elements of the knowledge-creating process of organizations (Nonaka et al., 2000).

The model of Nonaka et al. is built up of three parts: the knowledge conversions (the SECI process), the context for knowledge conversions (the 'ba') and the knowledge assets of a company (Figure 4). In this study, the first two parts of the model (the knowledge conversions and context for the knowledge conversions) will be examined whilst the third part (knowledge

assets of a company) is left out of the scope of the study. Knowledge assets are defined as "firm-specific resources that are indispensable to create values for the firm" (Nonaka et al., 2000, p. 20). These refer to the outputs of the knowledge conversions as well as the facilitators and moderators of the knowledge conversions and 'ba' (e.g. skills and know-how, product concepts, patents and licenses and organizational culture).

The aim of this study is to examine how the model of Nonaka et al. fits to analyze knowledge conversions in knowledge work: whether all the knowledge conversions can be identified in knowledge work, how these conversions are emphasized and what are the methods for accomplishing these conversions. This knowledge is important in understanding the dynamics of knowledge work and being able to improve the process of knowledge creation.

In the following, the model of Nonaka and his colleagues will be introduced in more detail. Firstly, the fulcrum of the model, the knowledge conversions (the SECI process), will be introduced. Secondly, the context for knowledge conversions ('ba') will be gone through. Finally, the path from individual knowledge to organizational knowledge will be discussed.

#### 1.2.1 Knowledge conversions

Nonaka et al. (Nonaka, 1991; 1994; Nonaka et al., 1994; Nonaka and Takeuchi, 1995; Nonaka and Konno, 1998; Nonaka, Toyama and Konno, 2000; Nonaka, Toyama and Nagata, 2000) define the knowledge creation as conversion of tacit knowledge into explicit, and vice versa. Accordingly, knowledge creation takes place through four different knowledge conversions: 1) socialization, where tacit knowledge is shared, 2) externalization, where tacit knowledge is articulated into explicit knowledge, 3) combination, where explicit knowledge is converted into tacit knowledge. These build up a spiral named as the SECI process (Figure 5).

In each of the conversions existing knowledge is "converted" into new knowledge. The knowledge creation forms a spiral continuing from individual, through group to organizational level. In socialization, tacit knowledge is shared between individuals. In externalization, "the sum of the individuals' intentions and ideas fuse and become integrated with the group's mental

world" (Nonaka and Konno, 1998, p. 43). In combination, knowledge is diffused to organizational level e.g. in digital form. In internalization, the individual identifies the knowledge relevant for herself and internalizes the knowledge into the organization's tacit knowledge. The four knowledge conversions of the SECI process are described in more detail in the following.



Figure 5. Knowledge conversions building up a SECI spiral (Nonaka and Takeuchi, 1995).

In **socialization**, tacit knowledge is shared without making it explicit in between. Nonaka et al. mention at least ten ways how socialization may take place: through apprenticeship including observation, imitation and practice (Nonaka, 1991); on-the-job training (Nonaka, 1994); through shared experiences (Nonaka, 1994), joint activities such as being together, spending time and living in the same environment, physical proximity, walking around inside the company (to access information at the actual job site and collect the latest information) (Nonaka and Konno, 1998); in informal social meetings outside of the workplace through creating and sharing world views, mental models and mutual trust, and wandering outside the company and getting ideas for the work (Nonaka, Toyama and Konno, 2000). The meaning of informal discussions e.g. over lunch has been noted by other researchers, too. Orr (1996, ref. Brown and

Duguid, 1998) has reported important incidences of sharing of know-how taking place at lunch or over coffee, when otherwise individually working technical experts tell "war stories" to each other.

In **externalization**, tacit knowledge is converted into explicit form. According to Nonaka et al., externalization may appear in several ways: creating new explicit procedures based on one's tacit knowledge, being able to articulate the foundations of one's tacit knowledge through reflection (Nonaka, 1991); translating the tacit knowledge of customers or experts to readily understandable form (Nonaka and Konno, 1998); creating concepts in new product development and using quality control circle to make improvements on the manufacturing process (Nonaka, Toyama and Konno, 2000).

Articulation is enhanced by dialogue that helps one to express ideas or images in words, concepts, figurative language or visuals (Nonaka and Konno, 1998). According to Nonaka et al., externalization takes place typically through metaphors and analogies: Intuitions give rise to associations of meanings that can be expressed by metaphors. Analogies then reduce the ambiguity by allowing the functional operation of new concepts to be explored by reference to things that are already understood (Nonaka, 1994). Thus, metaphors serve free associations whereas analogies are more structural and are carried out through rational thinking. Based on metaphors and analogies, finally a model for the product is developed.

**Combination** is the process of using the social processes to combine different bodies of explicit knowledge held by individuals (Nonaka, 1994). Combination can happen by sorting, adding, recategorizing, and recontextualizing of explicit knowledge that can lead to new knowledge. This can take place through gathering information from different data sources (Nonaka, 1991); through meetings and telephone conversations (Nonaka, 1994); and through presentations, and editing and processing of explicit knowledge (Nonaka and Konno, 1998). In combination, computerized communication networks and large-scale databases can be used to facilitate the process (Nonaka, Toyama and Konno, 2000). Combination is an essential process of diffusing the knowledge in an organization (Nonaka and Konno, 1998).

In **internalization**, explicit knowledge is converted into tacit knowledge. Internalization has some similarities with traditional notion of 'learning' (Nonaka, 1994) that can be defined as a change in an individual's behaviour based on new knowledge. In internalization, explicit knowledge is used to broaden, extend, and reframe individuals' tacit knowledge (Nonaka, 1991).

Internalization is rooted in action (Nonaka, 1994) to embody explicit knowledge in practice. It may take place by learning-by-doing, as focused training with senior mentors and colleagues, and exercises, and can be triggered by simulations or experiments (Nonaka and Konno, 1998) as well as reading documents and manuals and reflecting upon them (Nonaka, Toyama and Konno, 2000) and sharing and trying to understand management visions and values through communications with fellow members in the organization (Nonaka, Byosiere, Borucki and Konno, 1994). Internalization may take place also in virtual situations. Internalization is not primarily based on analysis but rather on peripheral and active participation (Nonaka and Konno, 1998).

#### 1.2.2 'Ba' - the context for knowledge conversions

Knowledge conversions take place in 'ba' (Nonaka et. al, 1998; 2000). Nonaka et al. have introduced a Japanese concept of 'ba' to explain the context for knowledge creation. Originally, the concept was proposed by Japanese philosopher Nishida (1970) and was further developed by Shimizu (1995). 'Ba' can be thought as "a shared space for emerging relationships" (Nonaka and Konno, 1998, p. 40). To further define the concept, Nonaka and Konno (1998, p. 40) state that "this space can be physical (e.g., office, dispersed business space), virtual (e.g., e-mail, teleconference), mental (e.g., shared experiences, ideas, ideals), or any combination of them". 'Ba' is also fluid, and can be born and disappeared quickly. The 'ba' can be connected together and form greater 'ba', e.g. "individuals form the ba of teams, which in turn form the ba of organization" (Nonaka et. al, 2000, p.19).

There are four types of 'ba' that correspond to the four knowledge conversions of the SECI process (Figure 6). These 'ba' are considered especially suited to each of the knowledge conversions and speeding up the process of knowledge creation (Nonaka and Konno, 1998).

For **socialization**, Nonaka et al. (1998) claim that an 'originating ba' is needed. In 'originating ba' feelings, emotions, experiences and mental models are shared. This happens through physical, face-to-face experiences. Care, love, trust and commitment emerge from 'originating ba' (Nonaka et al., 2000).



Figure 6. Four types of 'ba' corresponding to the knowledge conversions of the SECI process (Nonaka and Konno, 1998).

Chua (2002) has empirically studied the influence of social capital on knowledge creation. He found out that in particular the relational dimension of the social capital as compared to the structural and cognitive dimensions was a strong predictor of the quality of the knowledge created. Structural dimension of social capital refers to the structure of one's social network; relational dimension to the quality of these relations (such as friendship and the bond between the parties); and cognitive dimension to shared representations, interpretations and systems of meaning among parties (Nahapiet and Ghoshal, 1998). Thus, according to the findings of Chua (2002) particularly the quality of the relationships (respect, friendship and bonding) has a positive impact on knowledge creation instead of just the quantity of the network. Furthermore, shared cognitive representations were neither as important in this respect as the quality of the relationships between the parties creating knowledge. These findings support the idea of

importance of love, trust, care and commitment emerging in 'originating ba' to initiate knowledge creation. Furthermore, von Krogh (1998) has examined the relationship between care and knowledge creation. He claims that care - serious attention, a feeling of concern and interest – is an important enabler for knowledge creation by evoking mutual trust, active empathy, access to help, lenience in judgement and courage.

Other researchers have found an effective way for sharing tacit knowledge in the emergence of 'communities of practice' (Brown and Duguid, 1998; 1991; Wenger and Snyder, 2000). Communities of practice consist of individuals who need to work together to put their know-how into practice, and whose know-how and sensemaking are shared, or who share a common interest in a certain subject which connects the individuals together. "Through practice, a community of practice develops a shared understanding of what it does, of how to do it, and how it relates to other communities and their practices – in all, a "world view" (Brown and Duguid, 1998, p. 96)." However, in light of Chua's (2002) findings, a more important aspect in communities of practice would be the quality of relationships than the shared cognitive schemata.

Communities of practice can be considered partly equal to 'originating ba' only described in different terms. However, Nonaka et al. (2000) consider that there are significant differences between 'ba' and communities of practice. Firstly, Nonaka et al. (2000) claim that in communities of practice members learn knowledge that is embedded in the community while in 'ba' new knowledge is created. Secondly, communities of practice have clear boundaries and identity that are set by the task, culture and history of the community. 'Ba', on the other hand, is fluid and can be changed quickly: "It is constantly moving: it is created, functions and disappears according to need" (Nokana et. al, 2000). Also the membership is more fixed in communities of practice than in 'ba'.

**Externalization** takes place in 'interacting ba' (Nonaka and Konno, 1998). The key in 'interacting ba' is dialogue as well as extensive use of metaphors. 'Interacting ba' is more consciously constructed than 'originating ba' and should include people with the right mix of specific knowledge and capabilities. 'Interacting ba' is also called 'dialoguing ba' and is defined by collective and face-to-face interactions (Nonaka, Toyama and Konno, 2000). Again,

von Krogh claims that care is a necessary enabler (1998) for this kind of 'ba' to take place: existence of care encourages people to use unconventional language, metaphors, and analogies, as well as questioning and changing the basis for legitimate and acceptable knowledge which accelerates the emergence of new ideas, products and services (von Krogh, 1998).

Other researchers have proposed methods for converting tacit knowledge to explicit one as well. Among others, Sutton and Hargadon (1996) have found brainstorming as a powerful tool for articulating and developing new ideas. They report on brainstorming sessions in an international product development firm, IDEO. These have many similarities with Nonaka's 'interacting ba': sessions consist of staff with diverse skills, meetings are held face-to-face, tacit knowledge is shared through sketching designs or through visual analogies and white boards are used to record the concepts and ideas. Furthermore, Nobeoka and Baba (2001) claim that new 3-D CAD systems provide a powerful tool for problem solving and abductive thinking.

The context for **combination** is 'cyber ba' (Nonaka and Konno, 1998) or in other words 'systemising ba' (Nonaka, Toyama and Konno, 2000). It is a virtual world where collaborative environment is created utilizing information technology. On-line networks, group-ware, documentations and databases are used for combination (Nonaka and Konno, 1998) as well as electronic mailing lists and news groups (Nonaka, Toyama and Konno, 2000). 'Systemising ba' is defined by collective or virtual interactions (Nonaka, Toyama and Konno, 2000). A great deal of knowledge management literature focuses on facilitating the combination process through e.g. 'knowledge managers', information systems and databases (Roberts, 2000).

'Exercising ba' supports the features of **internalization** and enables on-the-site experiences. 'Exercising ba' is defined by individual and virtual interactions (Nonaka, Toyama and Konno, 2000). In 'exercising ba' explicit knowledge embodied may be communicated through virtual media, such as written manuals or simulation programs. Experimenting by utilizing computer simulation and rapid prototyping has been showed to increase overall development efficiency in product design and development (Thomke, 2001). As stated earlier, internalization has similar aspects to the traditional notion on learning.

#### 1.2.3 From individual knowledge to organizational knowledge

In the model of Nonaka et al., organizational knowledge creation process is described as a continuous spiral continuing from individual to organizational level. Nonaka (1994) claims that organizational knowledge creation is inherently knowledge creation of individuals which is organizationally amplified and crystallized "as a part of the knowledge network of organization" (Nonaka, 1994, p. 17). The knowledge creation of individuals happens "in an informal community of social interaction" (Nonaka, 1994, p. 17).

Although any of the four modes of knowledge conversion can create new knowledge independently, Nonaka (1994) considers as the central theme of organizational knowledge creation the dynamic interaction between all four: "A lack of commitment and neglect of the personal meaning of knowledge might mean that pure combination becomes a superficial interpretation of existing knowledge, which has little to do with here-and-now reality. It may also fail to crystallize or embody knowledge in a form that is concrete enough to facilitate further knowledge creation in a wider social context. The "sharibility" of knowledge created by pure socialization may be limited and, as a result, difficult to apply in fields beyond the specific context in which it was created." (Nonaka, 1994, p. 20).

According to Nonaka (1994) individual knowledge develops to organizational knowledge through processes of enlargement of an individual's knowledge, sharing tacit knowledge and conceptualization, crystallization and finally justification of the knowledge. Enlargement of an individual's knowledge takes place in three ways: by increasing the variety of individual's experience related appropriately to the individual's existing know-how, by "embodiment of knowledge through a deep personal commitment into bodily experience" (Nonaka, 1994, p. 22), and by rational ability to reflect on these experiences. The first two are concerned with raising the quality of individual's tacit knowledge and the third balances these with development of individual's explicit knowledge.

To convert the individual knowledge to organizational knowledge, the next step is to articulate and amplify it through social interaction (Nonaka, 1994). According to Nonaka, this can take place e.g. in "self-organizing teams" (p. 23) which are like Brown and Duguid's (1991) 'evolving communities of practice'. Two processes are triggered: "First, it facilitates the building of mutual trust among members, and accelerates creation of an implicit perspective shared by members as tacit knowledge... Second, the shared implicit perspective is conceptualised through continuous dialogue among members." The dominant mode of knowledge conversion in the first process is socialization and in the second process externalization.

The next step in creation of organizational knowledge is crystallization (Nonaka, 1994). This is the phase in which knowledge is created into concrete form such as a product or a system. "Crystallization may then be seen as the process through which various departments within the organization test the reality and applicability of the concept created by the self-organizing team. These internalization processes are facilitated by encouraging experimentation." (Nonaka, 1994, p. 25). This happens in the internalization mode of knowledge conversion. Finally, the organizational knowledge is justified by the organizational standards. In this process, the middle or top management evaluate whether the knowledge created in the organization is truly worthwhile for the organization. (Nonaka, 1994).

Crossan, Lane and White (2000) have proposed an organizational learning framework for purpose of strategic renewal. This framework has many similarities with Nonaka and his colleagues' model. In Crossan, Lane and White's (2000) framework learning proceeds from individual to organization level through four processes: intuiting, interpreting, integrating and institutionalising. Intuiting is an individual process and is about the preconscious recognition of the pattern and /or possibilities inherent in a personal stream of experience. In interpreting, insights or ideas are explained in words or actions to oneself and others. It is a process from the preverbal to the verbal. Integrating is a group level process in which shared understanding is created through dialogue and shared action. Finally, institutionalisation takes the learning to organizational level by ensuring that routinized actions occur by defining task, specifying actions and putting organizational mechanisms in place. The process of these four steps in the three levels is iterative.

Like in the model of Nonaka et al., in Crossan et al.'s (2000) framework the organizational learning starts from the individual level. Intuiting in Crossan, Lane and White's framework is

about exploiting one's tacit knowledge in new situations and generating new insights as making novel connections and discerning possibilities. Like in Nonaka and his colleagues' model intuitions are made explicit using metaphors. Metaphors are the start of interpreting process. The second level of interpreting is similar to externalization, but in this framework its focus is on the change in the individual's understanding and actions even though it involves dialogue and conversation. The group level is reached by process equal to socialization, creating shared understanding in integrating. This happens through dialogue and shared actions in context like communities of practice. Thus, sharing of tacit knowledge and conceptualization take place in this framework in reverse order compared to the model of Nonaka et al.. Finally, in institutionalisation knowledge is internalized into organizational routines. This final phase differs from Nonaka's crystallization even though they are both processes of internalization. In crystallization the transformation of knowledge into something concrete like a product or a system is emphasized instead of mere organizational routines.

Both models involve both exploration and exploitation in organizational learning and knowledge creation. In the model of Nonaka et al. exploration happens especially in externalization, and exploitation in combination and internalization. In Crossan's framework, on the other hand, exploration takes place as learning moves from individual to organizational level and exploitation in reverse direction. In both models, the keys for individual learning and knowledge to become organizational learning and knowledge are the social processes and group dynamics through which the individuals interact with each others.

Hence, Nonaka and his colleagues have made significant efforts on theorizing on the dynamics leading to knowledge creation in companies. However, there are some critics on their model as well. Tuomi (1999) has analyzed the SECI process and pointed out areas where it can be clarified and improved. E.g. combination concerning only combining and systemizing existing explicit knowledge is practically impossible as individuals process knowledge against their existing meaning structures which are tacit. In this sense, combination does not fundamentally differ from externalization (Tuomi, 1999). In this study, combination is perceived as a process in which working and utilizing existing explicit knowledge is in essential role and the output of the process is in explicit form. Externalization, on the other hand, is perceived as a process in

which the inputs of the process are to a great extent tacit and routine handling of explicit documents is not in central role in the articulation process. Furthermore, Tuomi (1999) points out that even though Nonaka and Takeuchi (1995) claim that knowledge conversions are social processes their concept of knowledge is still individual.

Stacey (2001), on the other hand, sees that the work of Nonaka et al. falls into the mainstream thinking about knowledge in organizations. According to Stacey (2001, p. 5) "Knowledge cannot be managed, and there is no need to manage it, because knowledge is participative self-organizing processes patterning themselves in coherent ways." This view draws on complexity sciences and emphasizes the radically unpredictable aspects of self-organizing processes and their creative potential. In this study, knowledge itself is not attempted to be managed but the interest is on describing the knowledge conversions in knowledge work in order to be able to support these processes better.

To conclude, knowledge creation is considered as an invaluable asset for companies to survive in the highly competitive global market. When perceiving knowledge creation as interaction between explicit and tacit knowledge, the knowledge conversions between these two form a critical aspect of knowledge creation in companies. Furthermore, in the third wave era knowledge work has outstripped the forms of agricultural and manual work. Management and understanding of the dynamics of knowledge work have arisen as a significant challenge of the beginning of this century.

After the SECI process was introduced to wider audience in the book 'The Knowledge-Creating Company' by Nonaka and Takeuchi 1995, the SECI process has approved to be an insightful and simple enough tool for many practitioners and researchers to grasp an understanding of knowledge creation in companies. However, Nonaka et al. have used mainly separate samples of operational work or examples of selected processes in certain companies to illustrate their model. Thus, it is not clear, how well it captures the knowledge conversion processes when systematically applied to a certain job and especially knowledge work.

# **1.3 Research questions**

The aim of this study is to increase the understanding of how the knowledge conversions take place in knowledge work. The knowledge conversions of knowledge work embedded in knowledge creation will be examined and the implications of these processes on transforming individual knowledge to organizational knowledge of companies will be discussed. The knowledge conversions in knowledge creation are examined in the framework represented by Nonaka et al. The knowledge conversions are examined in individual and group level in four cases: two presenting software design work, one software research work and one real estate strategy and process development work. The criteria for the selected cases were that the work should be knowledge work embodying knowledge creation as an inherent part of the job.

The theoretical goal is to systematically apply the model of Nonaka et al. into knowledge work and examine how the knowledge conversions are realized in it. The results will also be applicable to help managers to support working practices that will lead to appropriate creation of not only individual knowledge but organizational knowledge in their company.

The research questions are:

How is the knowledge conversion model of Nonaka et al. realized in knowledge work?

- a) Can all the four knowledge conversions be identified in the knowledge works studied? Do the different kinds of knowledge works involve sharing of tacit knowledge (socialization), converting tacit knowledge to explicit (externalization), combining explicit knowledge (combination), and internalizing explicit knowledge into tacit knowledge (internalization)?
- b) Are all the four knowledge conversions equally emphasized in the knowledge works studied?

c) How are the knowledge conversions carried out in the knowledge works studied? What are the methods for socialization, externalization, combination and internalization in the different kinds of knowledge works studied?

# 2. Research methods and material

## 2.1 Research approach: descriptive case study

The research approach in this study is hermeneutic meaning that the aim is to *understand* the phenomena under study by making *interpretations* of the phenomena by the researcher. Thus, the ontological view in this study is idealist and constructivist rather than realist. In the idealist perspective, the world is seen as constructed by the individuals' perceptions while in realist perspective there exists an objective reality independent on the observer (Raunio, 1999). Following, the epistemology in this study is dialoguing rather than dualist. The data of the phenomena is not gathered by standardized and objective measures but by empathizing and interacting in dialogue with the research objectives (Raunio, 1999). However, the research strategy is not exceedingly participative, and the research has some dualist features as well.

The research methods in this study are qualitative which corresponds to the ontological and epistemological assumptions of the study. Furthermore, qualitative methods are appropriate when the research subject is not well known and the context of the subject is important (Creswell, 1994). This study represents an interview-based qualitative study, in which interviews and non-participant observations are the main sources of data (Bryman, 1989). This kind of design brings about an outsider element to the study as the researcher's involvement in the organization is less marked (Bryman, 1989). This causes a subject-object relationship between the researcher and research objectives entailing dualist features to the study.

The research approach in this study is case study. Case study is the most suitable method when the research tries to answer to question "how", the researcher cannot control different factors effecting on the studying subject (Yin, 1994), and the phenomenon under study is not readily distinguishable from its context (Yin, 1993). This applies to studying knowledge conversions: the dynamics and the processes of knowledge creation are dependent on the context – knowledge workers are socialized to the environment which directs their perceptions and behavior (Turvani, 2001). Thus, knowledge conversions should be examined in real work context to grasp the richness of the actual knowledge conversion processes.

Furthermore, the study is a descriptive multiple-case study. The aim of descriptive studies is to present a complete description of a phenomenon in its context (Yin, 1993). In descriptive case studies, theory plays an important role in prioritizing the data collection and in interpreting the data covering the scope and depth of the object (Yin, 1993). Thus, theory is used in this study to focus on the defined processes of knowledge conversions and to explain the diverse patterns in the actual data. The multiple-case design involves two cases with exact replications presenting same kind of knowledge work, software design work, and two cases with predictably different replications presenting different kinds of knowledge works: software research work and real estate strategy and process development work.

#### 2.2 Research process and methods

To study the knowledge conversion processes of knowledge workers, individual interviews and group interviews were made together with a two-week observation period in each case site. Each case study was started by an interview with the manager of the case group. The aim of the interview was to get an overall picture of what the group was doing, who belonged to the group, and how they worked. The manager interview was followed by the individual interviews. As the individual interviews were completed, the group interview was made. The group interview consisted of the same persons who had participated in the individual interviews. Observation period followed the group interview.

As the cases in the study were selected presenting knowledge work embodying knowledge creation as an inherent part of the job, the interviewees were asked in the **individual interviews** to merely describe their work instead of asking how they created knowledge or what kind of knowledge conversions their work contained. The reason for this was that concepts like 'knowledge creation' evoke different conceptions between individuals and the interviewees' answers would have reflected their image of the concept and their ability to analyze and reflect their work in terms of the concept. Furthermore, term 'knowledge conversion' would have been probably even more vaguely understood. Rather, the interest was in the interviewees' everyday work and their tasks and how these were accomplished as the knowledge conversions and knowledge creation were embedded in these processes.

Thus, the aim of the individual interviews was to get the interviewees to describe how they worked and accomplished their work tasks in order to make conclusions on the different knowledge conversions embedded in their work by the researcher. The individual interviews were semi-structured, one-hour interviews with background information and one opening question following with specifying questions based on the responses of the interviewees. In the opening question, the interviewees were asked to describe their work as the interviewee perceived it. In describing their work, the interviewees were encouraged to use paper and pen to sketch their work similarly on paper<sup>1</sup>. Based on the interviewee's description and drawings further questions were asked in order to get a more detailed description of what were their main tasks, how did they accomplish these tasks, how did they work, what kind of social interaction and communication they had in their work and what was their typical working day like (Appendix 1).

The picture of the interviewees' work and knowledge conversion processes was supplemented in the **group interviews**. In the group interview, the interviewees were asked to analyze their work by themselves in the frame of the SECI process. Group interview was made to all of the interviewees together in each case. In the group interview, the interviewees were asked to evaluate how much each knowledge conversion was involved in their work and what kind of work tasks each conversion embedded. Instead of names socialization, externalization, combination and internalization e.g. following phrases were used: 'Trying to understand the other's ways of thinking, sharing mental models', 'crystallizing fuzzy thoughts, translating implicit ideas into explicit form', 'refining and systemizing explicit knowledge' and 'internalizing, implementing into own working habits'. These phrases were explained in some more detail by the researcher and the interviewees were encouraged to ask further questions. The interviewees were asked to force all their work tasks into these categories and make a group decision on how many percents each category covered in their work, total being 100%. The phrases were hung across the wall during the interview session. (Appendix 2).

After the individual and group interviews, the researchers observed the case sites for a twoweek period each. The **observations** were non-participatory. One researcher at a time sat at a

<sup>&</sup>lt;sup>1</sup> This method was suggested by the other researcher in the project, M.Sc. Marja Kauttu.
desk in a regular working place, which happened to be empty during the observation period, in the case site. The particular working place was selected so, that the researcher could see most of the interviewees while they were working without interrupting their work. The researchers also walked in the work space to see, what happened e.g. in the corridors, meeting rooms and coffee corners. The aim of the observation was to watch whether the interviewees worked individually or together with others, how they communicated with each other and what kind of social interaction they had going on. Every action like talking, walking, meeting somebody etc. that took place in the area was committed to writing and recorded on a computer file. The observations provided data on how the knowledge conversions were carried out – whether those took place alone or in interaction with others.

All the data were gathered as a research group, into which the author of this study belonged together with M.Sc. in Arch. Marja Kauttu<sup>2</sup>. In all individual and group interviews both researchers were present. During observation periods only one researcher was present at a time. Usually one researcher was observing before and the other one after noon. Notes of the observations were written on a computer file.

# 2.3 Research material

# 2.3.1 Selection of the cases

The unit for the cases was defined as a group of individuals doing similar kind of knowledge work. In selecting the cases for the multiple-case study, an exemplary case design was used. Exemplary case design means that cases selected reflect strong, positive examples of the phenomenon of interest (Yin, 1993). Two criteria were required: 1) the content of the work in the case should be such that creation of knowledge is an important part of the job; and 2) individuals in a particular case should be doing similar kind of knowledge work. Two of the four cases were selected as presenting similar kind of knowledge work in different contexts. The other two cases were selected as presenting different kinds of knowledge works. As the data was gathered from real work contexts and required commitment of time and resources

<sup>&</sup>lt;sup>2</sup>M.Sc. Marja Kauttu gathered similarly data for her dissertation thesis concerning innovation and place.

from participating companies, the selection of different types of knowledge works was mainly due to the willingness of these companies fulfilling the selection criteria to participate in the study.

# 2.3.2 Description of the cases

The study comprised of four cases that represented different kinds of knowledge works. Two cases dealt with software design work, one with software research work, and one with real estate strategy and process development work. In case A doing software design work, architectural design of the software was given and the designers were responsible for detailed design, coding and debugging of the software. The task of the group was to do analysis, module design, coding, module testing and integration testing. In analysis phase, the designers familiarized themselves with the requirements and standards; in design phase the software design was created; in coding and testing phase the designers wrote the code and tested whether it worked; in integration phase the whole software was integrated and the pieces created by individual designers were put together. The group was not responsible for initiatives for the projects but the tasks were quite well defined when the case group started their work. The group consisted of 15 software designers.

Case B included software design work from software concept and requirement analysis to system testing. The designers were involved in the whole process beginning with meeting with the customer and ending up with delivering the product. Their work also contained analysis, design, coding, testing and integration phases. The designers worked in teams of 2-10 designers.

The software researchers' task in case C was to apply new ideas to software and create projects with business units to implement these ideas. They explored what was new in the area of software research and development and suggested new projects for different business units in which they utilized their own expertise to improve the competitive advantage of the business units. Most of the co-operation they had was with other units than their own. Anyhow, they identified themselves as members of their own unit even though they had long relations to other business units in which they also worked physically for certain periods of time. Their work

involved both business and academic goals such as writing dissertation theses. Their task was to focus entirely on the research work and their work contained very little administrative tasks or co-ordination which would have taken time and effort from the research work. The work of the researchers was individual and there was minimum amount of external control of their work.

In case D, the real estate experts' task was to support their customer managers in their own field of expertise like workplace planning or investment, and maintain relationships with the customers and partners. The real estate specialists made extensive use of their experience to support the staff in the field and to build and maintain good partner relationships. Their main working tools were computer and mobile phone but their work also involved a lot of meetings with customers or partners. Significant part of their work was embedded in these meetings. The real estate experts worked in different kinds of teams.

The four case studies were done in three companies. Cases A and C were done in a global company in electronics industry. Case B was an IT service provider whose services included software development, consulting, and training. Case D was done in a government owned enterprise responsible for managing and letting property assets.

The interviewees in each case were named and selected by a manager of the case. The manager was asked to select the interviewees from their unit as presenting a representative sample of the group: preferable presenting different genders, nationalities as well as work tasks and experience in the group. In case A, four designers were interviewed. These were three men and one woman. Their ages varied from 28 to 52 (mean age 38 years). Three of them had a Master's degree and one had technical education in electrical and communications engineering. They had worked in their current job for app. 2 years. In case B, five designers were interviewed, four of them being men and one woman. Their ages varied from 23 to 30 years (mean age 25 years). They all had a Master's degree in computer science and engineering. They had worked in their current job for 1.5-2.5 years. In case C, all the six researchers of the group doing software research work were interviewed. Five of them were men and one was a woman. Their ages varied from 26 to 49 years (mean age 33 years). They all had a Master's degree in computer science. Five of them had worked in their current job for 2-3 years, one for 10 years. In case D, seven real estate experts were interviewed. Their ages varied from 35 to 60 (mean age 53

years). Three of them had a Master's degree in architecture, one in surveying and one in civil engineering. One had a degree of Bachelor of Arts and one had technical education on civil engineering. They had worked for the current enterprise and its predecessors on average 18 years (from 3 weeks to 28 years).

# 2.3.3 Data analysis

The data from individual and group interviews were analyzed using content analysis. The first step in starting the content analysis is to define the unit of analysis (Robson, 1993). In this study, it was defined as a unity of thought. One unity of thought constituted a meaningful idea and it could be consisted of several sentences. In the first phase of analysis, the data were analyzed deductively grouping the data into categories extracted from theory (Tesch, 1990), into the four knowledge conversions. Each unity of thought related to the description of the knowledge conversions that emerged in the interviews was categorized based on whether it was about sharing tacit knowledge (socialization), making tacit knowledge explicit (externalization), working with explicit knowledge (combination) or internalizing explicit knowledge into tacit knowledge (internalization). Reasoning into which knowledge conversion category each unity of thought belonged was based on the descriptions of each knowledge conversion made by Nonaka et al. For example, taking customers into sauna was grouped into socialization category even though the interviewees did not necessarily specify what kind of knowledge was shared in sauna. The judgement was done based on Nonaka's definition that informal situations and places (as the interviewee had described sauna) are ba for socialization. Likewise, processes in which working with and utilizing existing explicit knowledge were in essential role and the output of the process was in explicit form were classified into combination category whereas processes in which the inputs of the process were to a great extent tacit and routine handling of explicit documents was not in central role in the articulation process were classified into externalization category.

In the second phase of data analysis, the categories into which the interview data were grouped in the first phase, were further analysed using principles of inductive content analysis (Krippendorff, 1980). In this phase, the unities of thought were read through repeatedly and were finally grouped into emerging subcategories. As a novel story was formulated in each case based on the rich interview data, the subcategories varied across cases. However, the subcategories in each case were compared with each other and the categories could finally be unified under headings of what, how and where.

Atlas-program was utilized in grouping and analyzing the data in both phases of the data analysis. Observations were used for the purpose of triangulating different methods and data sources. In observations, different aspects of work than described in the interviews became evident for the researchers and hence fulfilled the picture derived from individual and group interviews.

# **3**. **Results**

Following, detailed descriptions of the knowledge conversions in each case will be presented. Quotations from the individual and group interviews will be provided within the case descriptions to illustrate the authentic phenomena. The results of each case will be summarized in a table in the end of each case description. The results will be concluded with a cross-case analysis, in which the results of each case will be compared to each other and the theory.

# 3.1 Case A: knowledge conversions in software design work

# 3.1.1 Socialization

In the software design work in case A, socialization took place in the beginning of the projects, when designers had to agree on interfaces and get a common understanding what was to be done. Coding was most individual of the phases and in this phase designers mainly worked intensively by themselves. In integration phase face-to-face communication was again necessary.

# A quotation illustrating socialization in integration phase:

Yeah integration phase. Maybe go... even go to somebody else's working place and discuss all the time. Because for each designer... they have their own work and if you, if you want to integrate them together it's not so easy for everybody else who can't understand. So... this is quite much co-operation between the designers.

In the software design team, the experience and area of experience varied. More experienced designers could help others as they had experience on how things had been done earlier. Also, the designers had expert knowledge slightly on different areas. Helping happened through constant communication between the designers and working together side by side. Work related tacit knowledge was shared in the cubicle area, in meeting rooms and in the laboratory. Helping and sharing tacit knowledge happened quite informally.

A quotation illustrating socialization taking place informally through constant communication:

Yeah... it is kind of constant communication - anybody may come anytime... and anyhow... and you can always go and ask. It is actually the nature of this job, it is communication when it is needed. And the whole day is like, it is not necessarily just coding, there can be also... kind of problem solving together.

Mental models, experiences and emotions were also shared during daily lunches and coffee breaks. App. 10 designers had lunch together on daily basis. Lunch was seen as "a high spot" of the day and everyday issues were discussed during lunch. Work issues were avoided. At lunch designers relaxed and got to know each other better. Designers also had coffee together but this was not as regular and pre-set activity as the lunch. Coffee breaks were more spontaneous and could happen at any time, usually in groups of 2-5 designers. Also some free time activities were arranged a couple of times a year, like Dragon row. These were considered as refreshing events.

#### A quotation illustrating socialization during lunch:

Hmm, why is it a high spot of the day? Well, it is nice to eat but... it is also open discussion with people, spontaneous discussion, not about work issues. You get to know the people, you can discuss what so ever.

# 3.1.2 Externalization

Much of the software designers' work was solving problems and getting ideas to go along with the coding. In the beginning of the projects designers needed to consult other people (experts and project managers) to get a picture of what they were doing. As things got clearer, designers worked mainly individually concentrating intensively on the task. Interruptions were experienced annoying in coding phase. Problems were usually solved by intensive concentration and working long enough on the problems at hand.

#### A quotation illustrating a problem solving situation:

In what kind of situation am I? It is a sweaty situation and I am concentrating very hard... and I kind of get a hint on something... or then it is a long, creative, or kind of... the solution just appears when you work with the issue long enough.

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Ideas, on the other hand, could emerge anywhere: at work or outside working hours. At work ideas could come from phone calls, at lunch, during a discussion, in front of a computer, as reading or in a meeting. Outside working hours ideas could appear etc. just before falling asleep or on one's way home.

#### A quotation illustrating getting ideas at home:

Probably at home…and during at night. It's so quiet. And sometimes… if I go to sleep… if I really had something, some problems during my work I may think later about it. And at this… try to figure out what… what kind of work I would do tomorrow, and maybe I try some other ways but… I try to sort them out.

# 3.1.3 Combination

Combination and sharing of explicit knowledge was in most significant role in these software designers' work. Sharing of explicit knowledge was important in every phase of the projects. In the beginning, project managers gave the designers their tasks and delivered the information related to the task. Throughout the projects there were weekly project meetings where designers told what they had done during the past week, what they were going to do next and what kind of problems they had had on their way.

## A quotation illustrating the importance of combination in the software design work:

Actually I'm a software designer ... so mainly the problem... What can I say? It's probably ... The problem, mainly, from the whole software are maybe some kind of information sharing. Because the project view... There are different aspects and I believe there are so many changes so we have to follow the project... quite well.

Designers sat in an open area in cubicles. They had constant communication going on all the time. If somebody needed to know something, he could ask anyone. If the person did not know the answer, he could point to some other person who might know the answer to the problem. Issues related to projects were also discussed during lunch, coffee breaks and in the laboratory. In coding phase, sharing of explicit knowledge happened mainly through e-mail as talking was

experienced annoying. Integration phase, on the contrary, required constant talking. During debugging phase there were meetings almost every morning.

## A quotation illustrating utilization of other people in information search:

...normally if you... not all the time... when you ask or talk to somebody else they can help you. But they might give you some kind of hint, or suggestion like... and sometimes they even suggest me to talk to somebody else they know of. Or they heard from somebody else or something... And try to find who is the expert of this area or something, like that.

Besides meetings, constant communication and e-mails, designers searched information from documents, requirements, books, Internet and Intranet. They also had to document their own work and deliver it to others. Reporting to project manager and colleagues also happened utilizing IT.

# A quotation illustrating information search from documents and books:

We have quite a large amount of documents - specifications, requirements and then all kinds of more general documents, I don't even remember the names of all the documents... and then we have books, new literature has emerged on the subject, in the beginning there were not good books on it, but now there are. It is now easier to get inside into the issue.

# 3.1.4 Internalization

Software design work required intensive concentration and understanding of the contents related to the work. Thus, internalization was an essential process in the software designers' work.

In the beginning of the software projects designers had to internalize a lot of information to get an understanding of what they were supposed to do. This happened mainly by reading documents and requirements from the company databases. One method of internalization was to put the most important documents on the wall to be stared at. Even though the internalization in the beginning was mainly reading, also discussions with project managers were important for the designer to know his role in the project. Also some formal training was sometimes offered when the area was new. Sometimes before real work simulations were also used.

#### A quotation illustrating use of simulator in internalization:

I began to examine our simulator, which means in practice that I can simulate in the PC the processor and its capabilities. I can put in code and see how the information moves in the registers, and see what happens and how it behaves.

Internalization in the beginning of the project was mainly an individual process. The designers did not know each other well and did not want to reveal their own confusion. There were a couple of experts on the area but the designers did not want to disturb them too much. Later in the projects problems were discussed also with others and sometimes these were solved together. In coding and testing phase internalization was mainly learning by doing: writing a code, testing whether it worked and modifying if necessary. This was also an individual process.

# A quotation illustrating the utilization of experts in internalization:

Normally they are some kind of... from technology point of view they have very high level of expertise. And some of our... how can I say this ...Key technical features ... It's mainly designed by them. So if we would like to know further, the more detailed, technical detail we would have to talk to them.

## 3.1.5 Summary

In case A, the software design work was mainly about utilizing existing explicit knowledge (combination). However, socialization, externalization and internalization played a significant role as well. Socialization took place as the work was team work and took place in an open space. The work also involved problem solving and externalization accordingly. An important aspect of the work was to internalize the requirements and develop one's know-how on the subject. The realization of the knowledge conversions in case A doing software design work is summarized in Table 1.

Table 1. Realization of the knowledge conversions in case A doing software design work.

<u>Socializ</u>	ation	Externa	alization
a) - - b) - - - - - - - - - - - - - - - -	<pre>what agreeing on interfaces getting a common understanding how helping others working together constant communication daily lunches coffee breaks free time activities where in informal situations in relaxed situations in open space office, in front of one's computer, in meeting rooms, laboratory, lunch and coffee areas, outside work socialization taking place more in the beginning and end of projects; coding individual work lization</pre>	a) - - b) - - - c) - - - - -	solving problems getting ideas to go along with the coding getting a picture of what is to be done <b>how</b> consulting project managers and experts intensively concentrating and working long enough on the problem at hand in coding phase alone, in analysis and integration also together <b>where</b> ideas could emerge at work from phone calls, at lunch, during a discussion, in front of computer, as reading or in a meeting ideas could appear also outside working hours, e.g. before falling asleep or on one's way home
a) what - - b) how - - - - - -	understanding the contents related to the work getting an understanding on what one is supposed to do improving one's expertise reading documents and requirements from the company databases hanging documents on the wall to be stared at discussions with project managers and experts formal training programs simulations learning by doing: writing a code, testing whether it worked and modifying if necessary	a) - - - b) - - - - - - - - - - - - - - -	<ul> <li>what getting instructions and information on the task</li> <li>searching knowledge utilizing existing codes documenting one's work reporting</li> <li>how</li> <li>weekly project meetings constant communication asking others</li> <li>e-mails</li> <li>processing and searching from documents, requirements, books, Internet and Intranet in the beginning and in the integration and debugging phase face-to-face combination emphasized, in coding phase information exchange through IT</li> <li>where</li> <li>in the open space, lunch and coffee rooms, laboratory, meeting rooms, at the computer</li> </ul>

# 3.2 Case B: knowledge conversions in software design work

# 3.2.1 Socialization

In case B, socialization happened between customers and designers as well as between the designers themselves. With customers the designers had meetings and working sessions in which the ideas and wishes of each party were conveyed. In the end of the projects they occasionally had sauna together with their customers.

#### A quotation illustrating socialization in meetings with customers:

Well, when we were planning the project we went to meet the customer even twice a week. We had meetings lasting half a day or even whole day and... questions were made and the customer introduced us their own... own world and what they've got there... what is their environment like and what they want from us.

Sharing tacit knowledge between the designers took place in project meetings and working sessions, in individual discussions, in intensive working sessions in pairs or little groups, at lunch and in different kind of sport activities. In project meetings the aim was mainly to share conceptual knowledge of the project status but it also included more informal communication and joking. This may have served as creating an atmosphere of solidarity, trust and safety. An other way of sharing tacit knowledge in project groups was working sessions, in which the members worked by talking and drawing on a big white board. The aim of these sessions was to create a common understanding on what was being or ought to be done. These sessions, of course, also included externalization and internalization.

## A quotation illustrating the project meetings as 'ba' for socialization:

Usually we have a weekly meeting in which we go through, and everybody tells what he/she has done... The meetings are quite cozy and usually... some joking... and discussion... and questions and so on.

Tacit knowledge was also shared in individual discussions and working in pairs or little groups. These situations were closest to apprenticeship: more experienced fellows helped others to solve problems and work was done together at someone's computer. Another way was that two or three persons were trying to solve a problem or figure an issue out and share their tacit knowledge in form of drafts and drawings. This was very close to externalization.

# A quotation illustrating sharing ideas together by drafting on paper:

Most of these issues we discuss together and then... one or the other starts to mess something on paper and... it is quite difficult... Often afterwards the papers that have been drawn can be thrown to waste and they are not... but anyway, in the situation it makes the communication easier.

One common way of sharing different world views and getting to know each other was having lunch together. In this case people had lunch in big groups. Another characteristic way of socialization in this case was playing pool and having many kinds of sports activities together. In sports you do not change conceptual knowledge but tacit knowledge of your attitudes and personality. Even though the tacit knowledge shared in sports does not directly relate to work, it makes people know each other better and may create trust among the players.

A quotation illustrating socialization by playing pool:

Well, of course mainly it is somebody sitting near to you... that you challenge to play... but we have also a category within the company in which you can challenge a player one or two steps above you. And in that you learn to know the persons well, unless you don't get stuck to same position. And like this... you learn to know people also from the other side of the building.

# 3.2.2 Externalization

Externalization was the most important knowledge conversion in case B. Externalization contained thinking and contemplation to figure out what was the task at hand, what should be done and how – including overall a lot of problem solving. In the beginning of the projects, the problems were wider and more abstract. As the project proceeded problems become more technical and specific.

Externalization took place individually and in groups of different sizes. In many cases some preliminary thinking and sketching had first been done individually and the sometimes faint ideas were then introduced to another person. Subsequently these were processed further together by thinking, reading, talking and making drawings on paper or on wall. Post-It papers

were also in effective use in sketching what was the phenomenon about. When introducing one's ideas to another person the ideas got tested at the same time.

A quotation illustrating developing ideas first alone and then with others:

Well, usually I try to sketch the first ideas of what we are doing myself. And then when I explain my ideas to another person... first of all, my ideas get tested but also... on average new and even better ideas are born as there are two or three people together.

When working together with one or two persons new and better ideas were usually thought to be evoked by riding on others' ideas and processing those ideas further. In the beginning of the projects, when issues were most unclear, working was preferred in pairs or in maximum in groups of three to figure out the task and solve quite abstract and wide problems. Architecture was seen as the realization of a vision of one or two persons. As the projects proceeded, work was done in bigger and bigger groups and externalization could take place in meeting rooms by going through the documents, discussing and drawing on a big white board to solve problems and to get a common understanding what was being done. This was closest to Nonaka's idea of dialoguing ba. Otherwise the work processes in externalization seem to differ from what Nonaka suggested as the way of working in 'dialoguing ba' and putting a right mix of expertise working together.

#### A quotation illustrating solving problems together:

If it is not a clear case and I can't find a solution quickly... then... then it is good to take some more time and usually more people... more people involved. Quite often we are here drawing on the white board, one or two people sitting on the table and one... draws and explains and then another one takes a pen and draws and ... in turn tries to find out what is the problem and what could be a solution.

In one interview, externalization was described taking place by e-mail: a document was sent back and forth between two persons and processed little by little. Gradually the document became to have a shape and was elaborated into something that could not be seen in the beginning.

#### A quotation illustrating externalization by processing a document through e-mail:

And now we have sent one document back and forth by e-mail, an e-mail with 500 rows... and little by little it gets more shape... Neither of us knew about the solution in the beginning... now it has began, little by little to come across.

Even though most of the externalization happened between workers of case B, some also took place with the customer. If the designers had problems or they did not understand something, questions were written down and discussed in meetings with customer. Half-day and whole-day technical meetings were arranged with the customer in which the issues were processed and worked on together.

#### A quotation illustrating technical meetings with customer:

And then we have these technical meetings, where we go together with our designers... or the project group goes there to meet the customer... and we go to a workroom and... and hit our heads together and fight or... in depends on the case...

Externalization took place also alone. Usually it was utilizing one's own experience and getting solutions to problems based on one's experience. Many solutions could be found by utilizing and combining existing solutions of which one had heard, read or already had experience about. If there was a block in thinking it was found useful to play pool or just walk to get one's mind out of the issue for a while. When getting back to work the blocks had usually gone and ideas to proceed seem to emerge more easily. Ideas and solutions to problems appeared also many times in peaceful situations – on way home in a bus or at night in a sauna.

#### A quotation illustrating 'ba' for ideation:

The best place to get ideas... is at home at sauna... usually the best. When you develop an idea... it is in your subconscious... and it usually hits you there.

Externalization was closely related to internalization: when starting to externalise the designers had to first internalize, what was it that they should be doing. That was in many times understanding the requirements. Then they could start to figure out solutions to problems – after

understanding the problem. Understanding the problem could also include externalization, because in many times in case B it was not clear what the problem was (they did not get requirements given ready as in case A). Between internalization and externalization there might be socialization – that is in case where this was done in pairs or in a little group. If there were no other person(s) involved there was no socialization happening either.

# 3.2.3 Combination

Combination of explicit knowledge was also an important process in case B. Their work was constantly building on prior body of knowledge. Thus, they utilized a lot of already existing explicit knowledge. Besides reading and searching from Internet this seemed to happen quite much by talking and asking others. Typically simple and general questions were asked from roommates and people near-by. Questions, problems as well as new thoughts were also expressed while playing pool or otherwise meeting people. Specific questions were also asked from people working in the same project. Designers were used to visit other project members' workspaces and discuss the problems or ideas at hand.

A quotation illustrating exchange of knowledge and information while playing pool:

It is a kind of a substitute for a coffee break to play some pool. It is like... you get some distance from the issue you are working on... you talk with people, you may just start wondering, how a problem could be solved and... would somebody have a hint or so on.

More formal ways of delivering explicit knowledge were project meetings and technology forum. Project meetings took place regularly once a week. Usually the project manager went through the project status by telling what had been done and what should be done next. Technology forum was a group of workers of the firm who represented the diverse expertise in the company. New technologies were discussed in the forum and areas of research were suggested.

A quotation illustrating the working of the technology forum:

I participate in our company's technology forum, we meet once a month... and we see what kind of new technologies we should study... and we decide who would

study what and then we will have presentations. And if it's something important, we finish the presentation and put it into our Intra so that everybody can read it... We are all together ten in the forum.

Combination happened also with the customer. In the beginning of the projects requirements were gathered from the customers. As projects proceeded meetings of projects' status were held with the customer as well as technical meetings. Questions and documents were also sent by e-mail. Some issues were also handled in the phone. In the end of the projects the client approved the documents through a formal procedure.

A quotation illustrating the approval process:

Actually the formality comes into picture when the documents are to be approved... At that point there should be found an acceptor, owner and what ever... And then everything is gone through that the documents fulfil the customer's requirements.

Even though face-to-face communication was typical of case B designers in combination, also IT was used as a tool. Version management and e-mail were used daily as well as Internet for surfing and information search.

# 3.2.4 Internalization

Typical situations of internalization were understanding what should be done and understanding the requirements of the clients. Internalization happened also in coding: coding was making the plan and papers into something concrete – into the first prototype. This included also testing – kind of learning by doing.

A quotation illustrating internalization of requirements with a pair:

We were a lot... there... and we stuck post-it slips on the wall and flap board and sketched and draw and read the specifications the two of us together... and sat around and thought about... thought about the software and tried to figure out... Internalization could happen either together with other people or alone. As output of working with a fellow or in a group could be a deeper understanding of the issue. Contemplation took also place while alone. One way of individual internalization was to study other people's programs and understand their content.

A quotation illustrating internalization by studying other people's programs:

I read a lot also during free-time and I write a lot of code at home, too... and I read code that has been written by somebody else and I study... study programs that I find from Internet... and of course books.

# 3.2.5 Summary

In case B, all of the four knowledge conversions played almost equal roles, even though externalization was slightly emphasized over the others. The work was done in teams and socialization was encouraged in many ways in the company. The work was about creating novel solutions to the customer and accordingly externalization was emphasized in case B. In the novel solutions existing explicit knowledge was also utilized. Thus combination was also an important process. Deepening one's expertise (internalization) was also an important aspect of the job. The realization of the knowledge conversions in case B doing software design work is summarized in Table 2.

Table 2. Realization of the knowledge conversions in case B doing software design work.

<u>Socialization</u>		<u>Externa</u>	lization
<ul> <li>creating</li> <li>solving</li> <li>how</li> <li>intensive groups</li> <li>helping</li> <li>drawing</li> <li>individu</li> <li>meeting</li> <li>lunch</li> <li>playing</li> <li>sport act</li> <li>sauna</li> <li>with the</li> <li>with the</li> <li>with the</li> <li>with the</li> <li>with the</li> <li>the with ot sport act</li> <li>c) where</li> <li>in the w</li> <li>in the w</li> <li>in the h</li> <li>at the co</li> <li>in the p</li> <li>in the p</li> <li>in the p</li> <li>in the p</li> </ul>	g, making drafts together hal discussions as and working sessions pool tivities e customer e team members hers colleagues, e.g. participants of	a) - - b) - - - - - - - - - - - - -	what figuring out what is the task at hand, what should be done and how solving problems, which were more wider and abstract in the beginning of the projects and become later more technical and specific coding how first individual thinking and sketching, then processing ideas further in groups of different sizes, the group size growing as the projects proceeded thinking, reading, talking and making drawings on paper or on the wall utilizing paper, pens, post-it slips and white boards riding on other's ideas and processing those further going through documents together and discussing processing a document by sending e-mail back and forth between designers getting solutions to problems by utilizing one's experience where at the work desk
Internalization		- - <u>Combin</u>	in meeting rooms in peaceful situations, also outside work
<ul> <li>underst</li> <li>b) how</li> <li>reading</li> <li>studying of</li> </ul>		a) - - b) - - - c) - - - - - -	<pre>what building on prior body of knowledge searching information how utilizing information technology: Internet, Intranet and e-mail talking with and asking others meetings and technology forum phone calls where at the computer at the workspaces in the meeting rooms in the pool room</pre>

# 3.3 Case C: knowledge conversions in software research work

# 3.3.1 Socialization

Socialization was taking place least of the four knowledge conversions in case C and was also most minimum in case C as compared to the other cases. However, socialization was important especially in the beginning of the projects and in updating new versions to know what the customer really wanted, that is, what the task really was about. This happened by discussing with the customer or project manager. Small technical meetings were considered valuable when working with the client. After the beginning of the projects, communication could diminish and took place mainly by e-mail. The results of the projects and the knowledge that was conveyed to the customer were basically in form of written documents. Delivering the results also included consulting and training in the business unit when the face-to-face communication increased again with the customer. The researchers had more co-operation with their clients than with the team in the same unit.

A quotation illustrating creating an understanding of the task together with a project manager or a client:

I must heavily listen to them (the customer)... and I must understand what they need and what are their problems and so on... In this face (in understanding the final target) it's fundamental the work of the project manager or the person that asked you to do the job. So it really has to give me an offer to figure out what I have to do. I'm asking him questions and I pretend in a way that explain me always better so I really push him to get more knowledge about what I have to do, what I'm going to do.

In some of the software researchers' work in case C socialization played an important role, even though it was not a big part of their work and took place occasionally. E.g. sauna provided an informal setting to discuss issues and share ideas. Also own office was a good place to discuss work issues as the researchers had all the material they could possibly need at hand. A couple of researchers found it very important to share their ideas with others and hear the others' view as well. The people with whom the ideas were shared had similar kind of background so that they could understand each other's ideas. For sharing of thoughts and ideas an informal environment was needed.

#### A quotation illustrating sauna as 'ba' for socialization:

Sauna is interesting place, because... in Finnish culture, the sauna is not the private place, it's public place... But the... type of conversation that you have in a sauna... is very very informal... it's a very very relaxed situation... generally. Now in... very very relaxed situation this gives you the chance to... think at things very quickly... in a sauna nobody is really worried by somebody coming with stupid ideas... We actually use the sauna quite a lot here. If we had conference here, then we'll take people down to the sauna and we have a sort of... very informal discussion about what's going on.

In case C there was in many cases also lack of socialization. Sometimes it was the choice of the software researchers themselves, sometimes socialization was missing despite the researchers' wishes. E.g. mentoring was in some cases desired but not available. Also some researchers would have wanted to work and discuss the work with other researchers but were left to work alone. Additionally, there was not much social interaction taking place during the working day which some of the interviewees felt even depressing. The researchers mainly worked alone in their offices and met other people during lunch time.

#### A quotation illustrating the lack of socialization:

Until now, actually, the beginning I was really disappointed because I was thinking I had not be left so alone like I was. And that one was a little bit even depressing. I mean the naturally the best way to start to work, especially if you are new to the workworld like permanent job like I was, I think the best way is that you work beside somebody with experience and you do perhaps less interesting stuff but you learn a lot because I had to learn new and methods to work. And the beginning I was left too much alone for my point of view I didn't like it. So the result is that perhaps I waste time on doing something that is not necessary or I don't spend enough time on something that is important. I waste time on looking for information that was supposed to be more easy to reach, because I don't know the way how to do it.

Unlike the others, two of the researchers communicated with their colleagues many times during a working day. They met and talked to people in corridors and coffee rooms, and they dropped by to each other's offices. This friendly chatting did not take place among the team members but the colleagues with whom they chatted were other researchers working in the same floor.

A quotation illustrating spontaneous conversations in the corridors:

I think I don't realize if I'm talking to someone else because it's very... sometimes you go there "Aaa , have you seen yesterday the movie?" Yes". Then you start talking: "Yes, do you matter?" and you start talking about your problem and it's there.

#### 3.3.2 Externalization

Externalization played the most essential role in the software researchers' work in case C. The contents of the work were such that the researchers had to do a lot planning. In the beginning of the projects they had to create a more or less clear picture of what they were doing and what the task was about. This process was iterative in a way that as the work proceeded they noticed new things that were not clear enough and had to come back to some previous step. As the output of their work was written documents their work also contained a lot of externalization in form of writing. The researchers usually utilized their own expertise to do the writing. As well as the outputs, also the proposals for customers had to be formulated into explicit form.

A quotation illustrating getting picture of the task at hand:

Take a workbook. And you write whatever. It doesn't matter in which direction you have the goals. Eventually, you just see where. Aaa... where you need to take it anyway. Umm, there's an analogy... where... on getting the idea, you're... if you need that, on side, there's all foggy in it... okay? You're guessing all the way. Things (...) left right, you don't know. When you get to... the fog lifts and you see exactly where you... ...where you went and where you should have gone. That's the process if you like. So it's basically idea to... do I take this path? No... go left, whatever. So you just search around the idea. Get the feel for what the area is like.

The software researchers spent a lot of time on getting ideas. Ideas could come from different sources and were usually embedded in utilizing one's experience and self-reflecting as well as abductive thinking. External sources for ideas were e.g. products and models applied in some other context, articles, documents, conferences, seminars and for some also discussions with

others. The ideas could come either inside or outside the workplace and working hours. Usually it was thought that ideas can emerge anywhere but they are best processed at workplace. Outside workplace ideas usually came up in relaxed situations when the brain was not working actively on something and there were no distractions.

A quotation illustrating getting ideas from similar products and documents:

And other one is looking the existing similar products. And this similar is very useful I mean becomes always well it could come that it doesn't exist something similar at all but that I can use the same model and develop a different, completely

different stuff. So, by that and ...other documents... so documents, the existing documents related to something that could be similar topic or different topic or the same topic but it can be useful to give me a picture of how to ... how to do my job.

#### A quotation illustrating 'ba' for getting ideas:

the shower and the toilet are the best places get ideas... Because the brains don't have to work on anything else, in that situation... At all. So you just, the brain just... does something... Um... It's... that place is... in general toilets and showers are very private places. One hopes... depends on the company of course... well, some time... So

there's absolutely no distraction at all, um... you're on your own, it's quiet... There you are not concerned about anything actively. Is what you're doing in there. Um... thus, the brain can just get on... and think. You just, braindwell. Turn brains on... So ideas just... come.

Some of the software researchers considered ideation being an individual process, some wanted to develop their ideas with others. E.g. white boards were utilized in sketching the ideas both individually and in groups. Ideas were also developed by first sketching them on paper, then hanging the core ideas on the wall, and after reaching some level of development writing those down on the computer. Computer was not usually utilized for externalization. Some of the researchers felt that their expertise varied so much from others that the complex things related to their work were not such that those could have been discussed with others. Thus, they also

created and developed their ideas individually. These researchers did not desire to have other researchers to share their ideas with.

A quotation illustrating the role of sketching and computer in externalization:

(...) yeah, and the computer and... you can change much easier... yeah, I see only one of them at a time and here you see... five of them and here's a big head drawing where I try to combine them... either the... the creative writing... drawing work always happens on paper in my case... If I'm finished I, I put it into the computer... let's say not finished, if it has reached a certain level of certainty. Then, I change to the computer... And then I print it... sorry about it, I print so many papers ... put it on the wall and then I change by... on the wall... Not on the computer.. And after we have changes out there then I make the update on the computer... This type of working style... Of course not such wise sometimes I just start really on the computer and...depends...

In case C internalization and externalization went hand in hand. Usually before being able to externalize the software researcher had first to internalize what he/she was doing. Between internalization and externalization there was not necessarily any socialization. Although, a natural place for socialization was between these processes when it took place. If externalization was a group activity then it could be preceded by internalization and socialization.

## 3.3.3 Combination

The software researchers' work in case C was not characterized by combination. Their work contained more internalization and externalization of knowledge than pure processing of explicit knowledge. However, combination occurred in information and knowledge search and in sharing of knowledge with colleagues and customers. The research was always building on prior body of knowledge. The researchers had to search through a lot of articles, documents and books to find the knowledge related to their research and set their research into the context. In case of a few researchers, information search was enhanced by asking other researchers. Information was also derived from the client or in some cases from the project manager of the project. Information and knowledge could also be asked from other researchers but the problem was they did not usually have the knowledge that was being searched for. Newsgroups abroad were also used for information search.

A quotation illustrating information search:

A lot, but I'm not reading books. I mean usually I read the, I try to find the what I'm interested in so few pages. Ok, the papers are very good in that because usually I find five pages of what you want. So actually most of the time I spend in not reading but finding the information. ... If you are able to make the question you

can find really many answers so, and then you read those papers so or the book you know you get, you go, usually somebody has the book here, we don't have a big library. Everybody orders books and then keeps it so you know who has the book and you go there and so, you know that you read it, so ok, "You know where I can find this problem?" so usually you just, ok, it's there so you read the chapter or ... so actually I'm, mostly I'm looking for the answer or for the paper more than reading but it's, I think it's quite good I mean because reading a book you need five hours five hours you... Of research right now you can find very much. Or discuss it with colleague, that's the best, if you know that somebody has the answer, you talk with him. So not only he answers you but usually also it gives you more ideas to other things.

Main channel for communication with colleagues and clients in work issues was e-mail in case C. The research work itself did not necessarily require face-to-face communication with others and besides e-mail, virtual discussion groups were also utilized in sharing information. Communication and sharing of information happened mainly with the customer and the certain business unit. Information exchange between the team members in the same unit was only remote although a few researchers also considered important to discuss their ideas with other researchers in the same unit to get further information and different viewpoints on their ideas.

# A quotation illustrating the main communication channel:

In this corporation normally through e-mail. People want to contact you through it, through e-mails... The company is very distributed as well. It's very hard to have face-to-face communication. But... it depends, I mean... you can be... in a situation where you just have... very low-key and formal communication for couple of months with somebody that you've never met.

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Explicit knowledge was also shared in different kind of meetings with the customer. These could be formal gatherings with PowerPoint-presentations or more informal meetings in which the documents developed in the project were discussed. Also telephone and video conferences were used as the groups were usually quite dispersed. The task of one of the researchers was more like one of a co-ordinator. Her work involved a lot of meetings and e-mailing inside her project team and with the customer. Combination played more significant role in her work than in the work of other researchers.

A quotation illustrating meetings with a customer:

They're arranged (meetings). Sometimes they're informal. But usually it's a formal meeting. Where you go on and make a presentation... It (the amount of people) can vary, two or three or twenty thirty.

#### 3.3.4 Internalization

Internalization was a key process in the software researchers' work in case C. It was a process that was going on all the time as the researchers increased and deepened their understanding of their field and the phenomena at hand. The researchers had to internalize and learn new things as their work proceeded to be able to create new solutions and solve the problems on their way. All the knowledge they acquired had to be affiliated to the complex entity. Also detecting problems and their causes required internalization. In the beginning of the project a crucial thing was to understand what the task was about to be able to accomplish the project. This required also understanding the customer's needs and wishes. As the understanding of the topic increased during the project, also the end result could vary from what was originally planned.

A quotation illustrating the internalization taking place during a project:

Well, the first one is a little bit difficult because well, you need a clear understanding of the topic and after you ask yourself: ok, did I understand it? You can say: yes. And after a while I think: no, no completely. So you have to come back. This one is quite difficult to realize the outcome because you ... well, it's very difficult for me to understand really when I understood completely the idea. I mean ... so I have to prove in a way that I understood... like... well, like mathematic. You do ... a demonstration for proving that it's not ...or that one thing is true if the contrary is false. Like...so this understanding is like... variable so it's like ... well, it

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can it's like a variable that change all the time during the project because on the while you go on you get more deep data and after you realize better what it is... and the understanding of the final target ... is a little bit ... more easy I would say. Once that you know that. So you have to understand what you have to produce but this is quite general anyway because... because you still don't know the target and so you need to know everything before understanding completely what you have to develop or study. And it usually comes during the project like ... a better understanding of this.

Increasing one's understanding took place mainly by reading alone. Especially useful was to familiarize oneself with existing similar products. By understanding functioning of similar products applied in different fields new insights could be created. Own mental models on subjects related to one's expertise were tested and improved by putting those in practice in the projects in business units. Based on the feedback these models could then be further verified and developed. Also this process was an individual one in case C. Internalization could also happen by walking and thinking.

A quotation illustrating the role of reading in familiarizing oneself with a topic:

So I plan my job and do like...a list of studies. So I mean a list of things that I have to understand to know to research to go on to the topic.

# 3.3.5 Summary

Converting tacit knowledge into explicit form (externalization) was clearly the most significant process in the software researchers' work in case C. Existing knowledge was also utilized as their work was building on prior body of knowledge. Internalization was also an important knowledge conversion in their work as they had to continuously deepen their own expertise. Of the four knowledge conversions, socialization played only a minor role in this case. The realization of the knowledge conversions in case C doing software research work is summarized in Table 3.

Table 3. Realiz	ation of the knowl	edge conversion	s in case C doir	g software research work.
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ation	Externalization
<ul> <li>what</li> <li>understanding the customer's requirements conveying the expert knowledge to the customer</li> <li>sharing ideas and hearing other's views</li> <li>how</li> <li>discussing with the customer or project manager</li> <li>sending written documents</li> <li>consulting and training in business units</li> <li>discussions with colleagues</li> <li>where</li> <li>in meetings, in business units</li> <li>in own office</li> <li>in lunch room</li> <li>in informal environment like sauna</li> <li>in corridors and coffee room</li> </ul>	<ul> <li>a) what <ul> <li>planning and ideation</li> <li>creating a picture of what they were about the do</li> <li>writing, creating written documents</li> <li>proposals for customers</li> </ul> </li> <li>b) how <ul> <li>utilizing one's expertise and reflecting on the abductive thinking</li> <li>getting ideas from products and mode applied in an other context, article documents, conferences, seminars art discussions</li> <li>sketching on white boards individually art sometimes in groups</li> <li>hanging core ideas on wall and processing those</li> </ul> </li> <li>c) where <ul> <li>inside workplace: mainly in own offic sometimes when meeting other people</li> <li>outside workplace: in relaxed situation conferences, seminars</li> </ul> </li> </ul>
	Combination
increasing and deepening one's expertise learning new things to be able to proceed and create new solutions affiliating new knowledge to the complex entity understanding what the task was about as well as the requirements of the customer <b>how</b> reading alone familiarizing oneself with existing similar products putting ideas into practice walking and thinking meeting the customer <b>where</b> in the office	<ul> <li>a) what</li> <li>building on prior body of knowledge</li> <li>knowledge search and sharing</li> <li>b) how</li> <li>searching through articles, documents ar books</li> <li>meetings with client and project manager</li> <li>asking other researchers</li> <li>e-mail, virtual discussion group newsgroups, telephone, video conferences</li> <li>c) where</li> <li>in own offices</li> <li>in meeting rooms</li> <li>at customer's site</li> </ul>
	understanding the customer's requirements conveying the expert knowledge to the customer sharing ideas and hearing other's views <b>how</b> discussing with the customer or project manager sending written documents consulting and training in business units discussions with colleagues <b>where</b> in meetings, in business units in own office in lunch room in informal environment like sauna in corridors and coffee room <b>lization</b> <b>what</b> increasing and deepening one's expertise learning new things to be able to proceed and create new solutions affiliating new knowledge to the complex entity understanding what the task was about as well as the requirements of the customer <b>how</b> reading alone familiarizing oneself with existing similar products putting ideas into practice walking and thinking meeting the customer <b>where</b>

# **3.4 Case D: knowledge conversions in real estate strategy and process development work**

#### 3.4.1 Socialization

Considerable emphasis in the real estate specialists' job was on building and maintaining good relationships with partners. Their work involved a lot of meetings with partners in which maintaining the good relationships was almost equally important as the content of the meeting itself. Also the content of the work itself was such that it involved a lot of negotiation with others and also the tasks were accomplished together in teams. The know-how of various people was needed and utilized. Furthermore, the work required good networks and knowing the right people.

# A quotation illustrating emphasis given on customer relationships:

The building developer consultant chairs the meetings, I am there just representing prestige. I am there to make the customer feel that we care about them when we are present in the meetings, even though... we would not be otherwise needed there, I could just send an e-mail that I have no issue to add in the meeting.

The real estate specialists worked in a building composed of open space and meeting rooms. They were sitting in the area in such positions that it was easy to communicate with the people near-by. Accordingly, they interacted with each other fluently and got to know each other better, and learnt also personal matters of each other. It was also easy to gather spontaneously and discuss work or other issues e.g. over a cup of coffee. Some real estate specialists had regular coffee breaks twice a day in which work issues were discussed in informal atmosphere.

## A quotation illustrating socialization enhanced by open space:

Yes, I have got to know much better our real estate managers. Earlier, when they sat… went to their own rooms, they sat there taking care of invoices and left to their sites, so I didn't see them... Not until now that we have changed to an open space I have learned to know the managers, when we sit together in the coffee table, we have one shared coffee table, and otherwise when they pass my desk when they go to toilet or get their mail or get something from

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the store or something else, and I have learned to know them very differently now, as persons.

Besides talking to neighbours, the real estate specialists also walked and went to meet colleagues sitting in other parts of the building. Regular face-to-face meetings were also arranged with the people working in the field and other parts of Finland. These face-to-face discussions were considered valuable and could not be replaced by e-mail. In the real estate specialists' work, face-to-face communication was considered most important, then speaking in the phone and not until third sending e-mail.

#### A quotation illustrating the meaning of face-to-face meetings:

No, it is not possible… I feel that you can handle by e-mail only substance related issues… decide whether to pay 1 million or 1.1 million for something… But if I had to discuss issues related to individuals, how they feel and experience things… I doubt… at least I can't convey my feelings on e-mail… I don't know if there are some poets who can quickly put their feelings in mail, I doubt.

Besides meeting colleagues in the work space, some real estate specialists also had lunch with certain colleagues. Also those specialists who were not having lunch regularly with the same people considered lunch-time an important way of interacting with colleagues and discussing other issues than work matters.

A quotation illustrating the role of lunch and coffee breaks in socialization:

Now, I'm going for a business lunch... but when I am here... it is one part of the working environment, coffee breaks and lunches, and an arena for social interaction, even if it is not always work issues being discussed, but you meet people, with whom you don't necessarily directly work with, and you get impulses there.

# 3.4.2 Externalization

Externalization was not in central role in all of the real estate specialists' work. Main expression of externalization was utilizing one's own expertise and know-how in various situations, in which the tacit know-how needed to be expressed in verbal form. This could take place e.g. when somebody requested for an advice or expert judgement on a certain issue. Additionally,

all the specialists had some tasks which involved writing and creating something not already existing – like certain letters or speeches. However, in some of the specialists' work externalization played a more significant role. Externalization was embedded in e.g. business process development. Business process development included e.g. building future scenarios, evaluating competitive strategies and portfolio management.

A quotation illustrating externalization as giving an expert judgement based on one's experience:

Quite seldom it requires me to go through some data or check something... usually questions are related to my opinions related to the business cases... or is it fine if one is doing this or that or do we have money for something... To these kinds of questions I can answer with the know-how I have without instantly going through some files...

In business process development, externalization took place in group discussions facilitated by a particular expert. Between the group meetings participants were asked to consider and ponder certain issues, but no information search or writing was included. Overall, externalization took place in interaction with other people – usually in little groups or together with just one person. In working with a pair, a fruitful atmosphere was considered open and trustful.

A quotation illustrating the social nature of externalization:

I am not good at thinking alone... yeah, I start to plod along and I can create good geometry but... it doesn't... the best ideas emerge as, as sparring... in that sense a scenario group is a nice environment.

The real estate specialists also had some problems they had to solve and ideas how to proceed. Ideas and solutions to problems could emerge anywhere. Ideas could easily come when not actively working on something, e.g. while walking. One method was to go through the issue and leave it then and let the unconscious do the work. Usually ideas needed some time to mature. Also one important source for ideas was interaction and discussions with other people. The ideas were also processed and developed together with other people.

A quotation illustrating externalization outside work:

Yeah, ideas can emerge anywhere, they can be born on horseback or they can... I usually walk my way to work and that is usually an environment where... the fresh air feels good and while walking, suddenly ideas can come to my mind, how things could be done... For example, if I have to write a memo, and I am wondering, how could I phrase the issue to be enough assertive but still polite, and usually when I am walking to the workplace, an idea may come about, this is how I will do it! But just walking, getting out of your desk, it helps to get ideas.

#### 3.4.3 Combination

The real estate specialists' work included also combining and refining explicit knowledge. These were usually routine tasks like searching information from databases and updating the databases, handling invoices, filling in standard templates and reading and answering certain types of e-mails. The real estate specialists considered keeping up with relevant information and reading and answering e-mails taking up a significant part of their working hours. Besides information relating to work at hand, the specialists also read magazines and newspapers to keep up with the current discussion.

A quotation illustrating tasks related to combination done on computer:

Okay, there is this project data system, into which every even tiny project has to be founded, it is our basic tool. And then there is this system where I get information, if I need to know some number or data, it is one tool. And e-mail of course, it takes daily app. 2 hours, it is a daily tool. And then electronic invoice acceptance... and then I got templates I use.

Sitting in the open space enhanced information distribution as one could deliver information to others immediately as it came to one's mind. Asking advices or piece of information was also facilitated by open space. Also spontaneous meetings and regular coffee breaks were natural ways of sharing and discussing work matters. Knowledge and information was shared openly and it was not considered as one's personal property. Working in the open space together with advanced information technology could sometimes be experienced also as negative information overflow, but this was no common opinion.

A quotation illustrating open space facilitating the information exchange:

Well, the interaction between colleagues has increased clearly, it is a necessity, I don't mean it is uncomfortable but vice versa. You got the people around you, you don't have to go to another room to ask a question or to discuss but you can do it at your own desk.

Explicit knowledge was also shared in arranged meetings. The real estate specialists had app. 1-4 different kind of meetings every day. The meetings were the most time-consuming single activity in the specialists' work. Especially bigger and formal meetings were usually arranged for changing explicit information. In smaller and more informal meetings the role of sharing tacit knowledge was also important.

A quotation illustrating different kinds of meetings embedded in the real estate specialists' job:

Yeah, and the meetings, let's say with all these... there are also meetings within our own house, with our own staff, inside the teams, and then these meetings with suppliers and customers, it is constant change of information and knowledge... And let's say, in our own working environment, the meetings are more spontaneous, you just meet the people. And then some business meetings, those are arranged.

## 3.4.4 Internalization

Converting explicit knowledge into tacit one occurred in change processes, in learning new working methods and ways of thinking and in exploiting feedback. There had been quite revolutionary changes in the company and the interviewees had had to adapt to these changes as well as learn new ways of working and thinking. In the change processes, internalization took place collectively by working and discussing together. Internalization took also place as reading and keeping up with the trends in the field. Internalization by reading was naturally an individual process.

# A quotation illustrating internalization by reading:

I usually print stuff, if I have to go through a longer e-mail, or prepare myself to a meeting. I print, and I can read on my way to a meeting or at the airport... And there are some newspapers and magazines I go through, just to know what is going on.

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# 3.4.5 Summary

Socialization played a key role in case D doing real estate strategy and process development work. The work contained a lot of face-to-face meetings with the partners as well as inside the company. Combination and internalization were also important, externalization being in least significant role. The realization of the knowledge conversions in case D doing real estate strategy and process development work is summarized in Table 4.

Table 4. Realization of the knowledge conversions in case D doing real estate strategy and process development work.

Socialization		Externalization			
with partners networking b) hor meetings wit accomplishin communicati having coffee walking arou people c) wh in the open sy in the meetin	maintaining good relationships and colleagues w h partners g tasks together in teams ng in the open space e or lunch together nd in the building and meeting ere bace	a) - - b) - - c) - - - -	<pre>what converting one's experience and know-how in various situations into words writing letters, speeches etc. business process development solving problems how group discussions facilitated by experts sparring with a pair interacting and discussing with other people where in meetings at the workspace outside work</pre>		
<u>Internalization</u>			Combination		
methods <b>b)</b> how - doing togethe - through chan	the new strategies and working er ge processes g and discussing the new issues	a) - - b) - - - - - - - - - - - - - - - -	<ul> <li>what</li> <li>searching information from databases and updating the databases, handling invoices, filling in standard templates etc.</li> <li>keeping up with relevant information as well as delivering it to others</li> <li>how</li> <li>e-mailing, utilising Intranet and Internet, working on computer reading magazines and newspapers communicating in the open space asking others</li> <li>spontaneous and arranged meetings</li> <li>where</li> <li>in the open space at the computer in meeting rooms</li> </ul>		

# 3.5 Cross-case analysis

Following, the results of each case will be compared to each other as well as the theory presented by Nonaka et al. (Nonaka, 1991; 1994; Nonaka, Byosiere, Borucki and Konno, 1994; Nonaka and Takeuchi, 1995; Nonaka and Konno, 1998; Nonaka, Toyama and Konno, 2000; Nonaka, Toyama and Nagata, 2000). First, the emphasis of different knowledge conversions across the cases will be examined. Second, the ways of carrying out the knowledge conversions across the cases will be compared to each other and the theory. Third, the context of the knowledge conversions across the cases will be examined to each other and the theory. Third, the reasons for the differences and similarities of the results between the cases will be discussed, and finally the implications of the findings on converting individual knowledge into organizational knowledge will be considered.

# 3.5.1 Emphasis of the knowledge conversions across the cases

In the group interviews, the interviewees evaluated themselves the emphasis of different knowledge conversions in their work (Appendix 2). These evaluations were verified with the data from individual interviews and observations by the researcher. Based on the research data, distributions of different knowledge conversions were approximated across the cases (Figure 7). Socialization was most important in real estate strategy and process development work (case D). Their work was quite much based on relationships and work was done in teams with diverse expertise. Meetings, discussions and working together were emphasized in their work. Socialization was important also in software design work (cases A and B) where the work was done in teams, too. On the contrary, software research work was done mainly individually and socialization played only a minor role in case C.

Externalization was in most significant role in software research work in case C. Their work involved recognizing opportunities for new software products and idea formulation. Their work usually started from intuitions and hunches which they had to produce into explicit form. Externalization was also important in the software designers' work in case B. In the real estate specialists' work (case D) externalization was not emphasized.



Figure 7. Approximate distribution of different knowledge conversions (socialization, externalization, combination, internalization) across the cases.

Combination was important in all four cases. In all cases, the employees had to utilize and work with already existing explicit knowledge. Combination was most emphasized in case A doing software design work in which existing codes were effectively re-used. Internalization played also an equal role in all four cases. In all cases the knowledge workers had to internalize what they were expected to do, understand the needs of the customer, learn new stuff in their field and deepen their own expertise.

# **3.5.2** Knowledge conversion methods across the cases

Besides the emphasis of different knowledge conversions varying across the cases, also the knowledge conversion methods differed, too. Almost all the knowledge conversion methods Nonaka et al. (Nonaka, 1991; 1994; Nonaka, Byosiere, Borucki and Konno, 1994; Nonaka and Takeuchi, 1995; Nonaka and Konno, 1998; Nonaka, Toyama and Konno, 2000; Nonaka, Toyama and Nagata, 2000) have introduced emerged across the cases (Tables 5, 6, 7 and 8). Overall, in software design and real estate strategy and process development work (cases A, B and D) face-to-face communication and interaction with others were much more emphasized than in software research work (case C). In the software research work studied, work was done individually and communication took place mainly virtually.
In socialization, all methods introduced by Nonaka et al. (Nonaka, 1991; 1994; Nonaka, Byosiere, Borucki and Konno, 1994; Nonaka and Takeuchi, 1995; Nonaka and Konno, 1998; Nonaka, Toyama and Konno, 2000; Nonaka, Toyama and Nagata, 2000) came up across the cases except of formal on-the-job training (Table 5). Also apprenticeship took place only informally and was not a formal policy in the cases studied. Especially in case B, the organizational culture with a lot of shared activities (like pool and sport activities) encouraged socialization, which also showed in their way of working and solving problems together. In case D, the specialist were used to building and maintaining good relationships with the partners as well as inside the company, and face-to-face interaction was characteristic of them. In case C, socialization was sometimes even lacking and accordingly the methods for socialization were not as rich as in the other cases.

Table 5. Methods for socialization	across the cases as	s compared to the methods	suggested by
Nonaka et al.			

Methods for socialization suggested by Nonaka et al.	Case A: software design work	Case B: software design work	Case C: software research work	Case D: real estate strategy and development work
Apprenticeship including observation, imitation and practice (Nonaka, 1991)	Informal 'apprenticeship' as working side- by-side in front of one's computer or in the lab	Informal 'apprenticeship' as working side- by-side in front of one's computer, going together to meet clients		Informal 'apprenticeship', working together in teams in different projects
Shared experiences (Nonaka, 1994)	Working together, having lunch together, individual discussions	Meetings, working sessions, lunch, sport activities, individual discussions	Some researchers had lunch together with others, some discussed with others	Long work history together, having a lot of face-to-face meetings with the customer and within teams
On-the-job training (Nonaka, 1994)	Informal	Informal		

Joint activities such as being together, spending time and living in the same environment (Nonaka and Konno, 1998)	Working in the open space office, constant communication, having lunch and coffee together, occasional free time activities	Working in rooms for 1-4 designers and open space, constant communication, playing pool, regular sport activities, sauna	Some researchers spent time together and had hobbies together, some could have sauna with the customer	Working in an open space office with easy communication, working in shared projects, having lunch or coffee with certain
Physical proximity (Nonaka and Konno, 1998)	Working in the same location and in an open space office; working physically together with others	Working in the same location, working and doing other activities by being physically close to each other	The group of researchers worked in the same location but spent most of their time alone; working occasionally also in the customer's site	colleagues Sitting in the open space office, visiting the 'field sites', spending a lot of time in face-to- face meetings
Walking around inside the company (Nonaka and Konno, 1998)	Wandering in the open space	Wandering in the floor, kitchen and pool room	Some walked around	Walking in the building and talking to others
Informal social meetings outside of the workplace (Nonaka, Toyama and Konno, 2000)	Occasional free time activities like dragon row	Regular sport activities (floorball etc.)	Some researchers met sometimes outside the workplace	Customer events like concerts, some had hobbies together
Wandering outside the company (Nonaka, Toyama and Konno, 2000)		Studying programs and codes at home, chatting in Internet	Connections outside the company important (e.g. university)	Networking and knowing the right people outside the company essential
Others			Tacit knowledge embedded in documents	

Methods for externalization were most plentiful in cases B and C, in which externalization played most significant role (Table 6). All methods for externalization mentioned by Nonaka et al. were utilized. However, in case B externalization was more a group activity while in case C it was an individual contemplation process. Dialoguing, which Nonaka considers a key process in externalization, was most vivid in case B with utilization of several simple aids: paper, pens,

post-it slips, white boards etc. In case D, dialoguing took place mainly by discussing with a pair or with a group of people in an arranged meeting.

Table 6. Methods for externalization across the cases as compared to the methods suggested by
Nonaka et al.

Methods for externalization suggested by Nonaka et al.	Case A: software design work	Case B: software design work	Case C: software research work	Case D: real estate strategy and development work
Use of metaphors and analogies (Nonaka, 1994)		Studying and utilizing existing solutions in the same or different area	Examining products and models applied in other contexts; utilizing knowledge from other areas	
Dialogue (Nonaka and Konno, 1998)	Discussing with project manager and experts to get a picture of the task	Talking, reading, thinking and sketching together using paper and pen, post-it slips and white boards, riding on others' ideas	Some researchers challenged their ideas by presenting those to others	Group discussions facilitated by an expert; sparring with a colleague; group meetings
Abductive thinking (Nonaka et al. 2000)	Unconscious associations as source of ideas	Utilizing one's know-how on solving problems; unconscious associations as source of ideas (see also above and below)	Creating new models, working on and processing ideas; unconscious associations as source of ideas	Unconscious associations as source of ideas
Self-reflection (Nonaka et al. 2000)	Intensive individual concentration on the task	Individual contemplation and sketching	Working on ideas, sketching the ideas on paper and walls; utilizing one's know-how on writing documents	Utilizing one's expertise and know-how

С	Others	do	rocessing ocuments by ending e-mail ack and forth	

All methods for combination were utilized across the cases (Table 7). In cases A, B and D faceto-face meetings were an important way of facilitating information diffusion. In these cases, there was a constant flow of communication going on in the work space. In case D, meetings, phonecalls and sending and reading e-mail constituted mainly the working day. However, in all of the cases computer was the main tool for working. In case C, communication took place mainly by utilizing information technology.

Table 7. Methods for combination across the cases as compared to the methods suggested by Nonaka et al.

Methods for combination suggested by Nonaka et al.	Case A: software design work	Case B: software design work	Case C: software research work	Case D: real estate strategy and development work
Gathering information from different data sources (Nonaka, 1991)	Asking others in the open space, discussions at lunch, coffee etc.; searching from documents, requirements, articles and books	Asking people near-by as well as the team members; discussing while playing pool; searching from documents and books	Searching from articles, documents and books; asking other researchers	Constant flow of information in the open space; searching from databases; reading e-mails, magazines and newspapers; lunch and coffee
Meetings and telephone conversations (Nonaka, 1994)	Constant communication in the open space; weekly project meetings	Regular project meetings; technology forum; meetings with clients, phone calls; spontaneous meetings	Meetings with the customer; phone calls; video conferences	Many meetings a day with the customers and the team members; making a lot of phone calls; spontaneous meetings
Presentations (Nonaka and	Presentations of	Presentations of	Giving and listening to presentations e.g.	Giving and listening to

Konno, 1998)	the project status	the project status	in conferences	presentations
Utilizing computerized communication networks and large-scale databases (Nonaka, Toyama and Konno, 2000)	E-mail; Internet; Intranet	E-mail; version management; Internet; Intranet	E-mail; Internet; Intranet; newsgroups; virtual discussion groups	E-mail; Intranet; Internet

In internalization, Nonaka et al. emphasize the importance of action and practice. Formal training programs are seen as ways of implementing organizational explicit knowledge into tacit knowledge of individuals (e.g. Nonaka et al., 2000). However, in these case studies formal training was not emphasized as a form of internalization at work. Instead, self reflection and reflection with others appeared to be important ways of internalization as well as experimentation (Table 8). Also reading and learning-by-doing were evident ways of internalization in all of the cases. According to Nonaka, Toyama and Konno (2000) internalization is defined by individual and virtual interactions. However, especially in cases B and D internalization was taking place as a result of reflection with others as well as in case D as a collective change in the ways of working.

Table 8. Methods for internalization across the cases as compared to the methods suggested by	
Nonaka et al.	

Methods for internalization suggested by Nonaka et al.	Case A: software design work	Case B: software design work	Case C: software research work	Case D: real estate strategy and development work
Learning-by-doing (Nonaka and Konno, 1998)	Coding and testing	Coding and testing	Testing one's ideas by implementing those in projects in business units; working in different projects	Working in the projects; changing one's way of working according to the changes in the company
Focused training with senior	Sometimes some	Working together with		

mentors and colleagues (Nonaka and Konno, 1998)	training courses	colleagues		
Simulations or experiments (Nonaka and Konno, 1998)	Sometimes rehearsing with simulations		Testing one's ideas by implementing those in projects in business units	
Reading documents and manuals and reflecting upon them (Nonaka, Toyama and Konno, 2000)	Reading documents and requirements from databases, hanging those on walls	Familiarizing oneself with other people's programs; reading	Reading and familiarizing oneself with existing similar products	Reading reports, e-mails, documents, magazines etc.
Reflection with others (Nonaka, Byosiere, Borucki and Konno, 1994)	Discussing with project managers and later also with the team members	Discussing with the client to create the requirements of the product; discussing with the client and the team members	Self reflection: Affiliating new knowledge into the complex entity; reflection with others: understanding the customers' needs and wishes	Discussions with colleagues

### 3.5.3 'Ba' for the knowledge conversions across the cases

'Originating ba', 'interacting ba', 'cyber ba' and 'exercising ba' could be identified to some extent in all cases. However, especially externalization, combination and internalization took place in other kinds of contexts as well. Externalization happened, particularly in cases A, B and C, also individually utilizing the same tools like paper, pens and white boards as when externalizing in dialogue with others. In case C, this was the dominant form of externalization. Besides sketching and contemplation, externalization took place also more spontaneously as kind of a result of unconscious maturing of the subject in one's mind. This kind of externalization happened apparently without effort and was not necessarily dependent on time, place or other identifiable stimulus.

Combination took place in 'cyber ba' which is featured by collective and virtual interactions (Nonaka, Toyama and Konno, 2000). However, in cases A, B and D a significant way of

sharing, acquiring and combining explicit knowledge was constant face-to-face interaction with others in the working space. Combination was facilitated by asking pieces of information from team members and colleagues as well as hearing other people's conversations e.g. in the open space. Meetings were also an important arena for sharing, acquiring and combining explicit knowledge. These methods for combination were collective activities but had a significant not virtual but here-and-now face-to-face element.

Similarly, some of internalization was a result of on-the-site experiences and learning by doing taking place in 'exercising ba', but self-reflection or reflection with others were also important aspects of internalization in all cases. Part of the internalization was characterized by individual and virtual interactions (Nonaka, Toyama and Konno, 2000) but especially in cases A, B and D it also happened collectively and face-to-face with others.

#### 3.5.4 Reasons for differences in knowledge conversions across the cases

Explanations for the differences in knowledge conversions and methods can be searched from e.g. the type of work, organizational culture, workspace, age and team versus individual work. The type of work varied across the cases. The first two cases (A and B) handled with software design work, the third case (case C) with software research work and the fourth one (case D) with real estate strategy and process development work. There were differences in the knowledge conversions between the different kinds of knowledge works but also between the two cases representing same kind of knowledge work, software design work (cases A and B): The methods for knowledge conversions were differing in cases A and B and also the emphasis of the knowledge conversions varied. These may be explained by the organizational enablers and the content of the work: in case B the work was more autonomous and the designers were responsible for whole projects instead of just some part of it. In case B, the designers were involved in making the requirements together with the customer whereas in case A the requirements were given to the designers. Thus, the work in case B involved more externalization than in case A while in case A combination was more emphasized.

The differing knowledge conversion methods between cases A and B may be due to varying culture in the cases. In case B, shared activities were spurred and the designers were e.g. encouraged to play pool with varying colleagues, and many kinds of regular sport activities

were arranged on behalf of the employer. The spirit seemed to be high and was congruent with the mission of the company in case B.

On the other hand, there seems to be many similarities in the knowledge conversion methods in cases A, B and D as compared to case C. In cases A, B and D the work was team work whereas in case C the work was mainly individual work. Furthermore, the designers and specialists in these cases were sitting in an open space or in an open space with rooms for 2-4 designers. In case C, the researchers sat in their own separate offices. Thus, the more social knowledge conversion methods may be due to doing team work and working in an open space. On the other hand, also the redundancy of knowledge in cases A, B and D may have enabled more social ways of carrying out the knowledge conversions.

Some differences between the cases may be also due to the age of the employees. Socialization was most heavily emphasized in case D, in which the mean age of employees was clearly highest of the cases studied. Maybe the older generation is more used to face-to-face interaction with others while the younger generation is used to explicit messaging e.g. through e-mail. However, e.g. in case B, where the mean age of the interviewees was youngest, also face-to-face communication was an important way of interacting with each other.

#### 3.5.5 From individual to organizational knowledge

As the interest of organizations to maintain and develop competitive advantage is not on knowledge creation of individuals but on organizational knowledge creation, the implications of the results on organizational knowledge creation will be next examined. According to Nonaka (1994) the central theme for organizational knowledge creation is the balance of all the knowledge conversions. However, in light of the results of this study, the balance means that each knowledge conversion takes place for reasonable amount but some conversion(s) may be emphasized according to the type of work at issue. E.g. in research and development work a heavy emphasis on externalization is probably even desirable.

The process of converting individual knowledge into organizational one takes place through five stages according to Nonaka (1994): enlargement of an individual's knowledge, sharing tacit knowledge and conceptualization, crystallization and finally justification of the

knowledge. When these five stages are compared to the case descriptions presented in chapters 3.1 - 3.4, following perceptions can be made. Enlargement of individuals' knowledge was evident in each case. This enlargement was related to the internalization process which was important in each case. However, the next step of articulating the knowledge through social interaction did not occur in each case: in case C this was an individual activity as well as to some extent also in case A. Especially in case C, the knowledge was delivered to others mainly in combination stage, which means that the knowledge is shared in impoverished form to others (von Krogh, 1998).

Crystallization, creating the knowledge into a concrete form like a product or system (Nonaka, 1994), took place in each case meaning that the knowledge was finally transformed into organizational knowledge in each case. The justification of the new knowledge by middle or top management was not in the scope of this study.

However, organizing the results into steps of enlargement of an individual's knowledge, sharing tacit knowledge and conceptualization, crystallization and finally justification of the knowledge is artificial. The processes embedded in the data seem to fit better to Crossan, Lane and White's (2000) framework for organizational learning. In this framework *intuiting* and *interpreting* are focused on individual processes of exploiting one's tacit knowledge and generating new insights which are articulated through metaphors involving possibly dialogue and discussions (Crossan, Lane and White, 2000). These processes were characteristic of all of the cases. However, *integrating*, which is a group level process for creating shared understanding through dialogue and shared action, was not again taking place in case C but was typical of cases B and D. *Institutionalisation* is a company-level process and was not in the scope of the data.

Thus, the differences in the knowledge conversion methods across the cases probably mainly affected the form the knowledge became available to others in the organization. The more social knowledge conversion methods gave others access to the rich tacit knowledge of individuals. As Chua's (2002) empirical study showed, social interaction seems to increase the quality of knowledge creation. However, even without socialization the knowledge become organizational through the crystallization phase, in which the knowledge was created into a concrete form such as a product. In this case, only tacit knowledge that was embedded in the

product became available to others instead of e.g. the tacit knowledge related to the process of developing the product. According to von Krogh (1998) this is typical of organizations where care runs low. In these kinds of organizations the personal expertise developed in the capturing process will not be transferable to other individuals in the team or group.

# 4 Discussion

The aim of the study was to increase the understanding of the knowledge conversions embedded in knowledge creation in knowledge work. The knowledge conversions were studied in individual and group level in four cases in three different kinds of knowledge works: software design, software research and real estate strategy and process development work. The selection criterion of the cases was that knowledge creation is involved as an inherent part of the work in the cases. The model represented and developed by Nonaka et al. (Nonaka, 1991; 1994; Nonaka and Takeuchi, 1995; Nonaka and Konno, 1998; Nonaka, Toyama and Konno, 2000; Nonaka, Toyama and Nagata, 2000) was used as a framework for analyzing the knowledge creation is interaction between tacit and explicit knowledge which takes place through four different knowledge conversions.

To increase the understanding of the knowledge conversions in knowledge work, the realization of the knowledge conversions in the three kinds of knowledge works was studied. The aim was to study whether all the four knowledge conversions presented by Nonaka et al. took place, how the knowledge conversions were emphasized and how the knowledge conversions were carried out in the knowledge works studied. Furthermore, implications of the knowledge conversion processes on transforming individual knowledge to organizational knowledge of companies were discussed.

## 4.1 Realization of the knowledge conversion model in knowledge work

All the four knowledge conversions (socialization, externalization, combination and internalization) of the knowledge conversion model of Nonaka et al. could be identified in each knowledge work studied. However, the emphasis of different knowledge conversions varied across the knowledge works studied. As will be further discussed later, it would probably be even desirable that one knowledge conversion may be emphasized over the others as a consequence of the contents and aim of the work.

Furthermore, the knowledge conversions seem to contain more delicate features and different levels within a conversion than described earlier e.g. in the conversion of tacit knowledge into

explicit one: Some externalization took place easily and was more about articulating tacit knowledge that had not just happened to be articulated earlier and did not require much effort, e.g. answering questions or making decisions based on one's know-how. Somewhat more difficult level of externalization took place when one had to express one's experience in written form requiring longer working and contemplation on the subject. Finally, a third kind of process of externalization seemed to be the one of coming up with new ideas, either accidentally and without effort or as a result of (group) contemplation. The differences between the first two processes versus the third one seem to support Scharmer's (2001) idea of two types of tacit knowledge: 1) embodied tacit knowledge that is based on one's experience, and 2) self-transcending knowledge that is tacit knowledge prior to its embodiment in day-to-day practices – knowledge enabling to invent e.g. new ideas and practices.

Furthermore, the cyclicity of the knowledge conversions in individual and group level may be more illustrative than literal. Externalization in this study was quite often preceded by internalization in the knowledge works studied – converting tacit knowledge explicit involved usually a goal that directed the process and the goal should first be internalized to be able to work effectively on it. Whether socialization took place between these two seemed to depend on whether externalization happened as an individual effort or as a group activity. However, socialization could take place also in different parts of the cycle, like together with combination: knowledge sharing could involve both sharing of explicit and tacit knowledge. Furthermore, the borders of different knowledge conversions are vague: externalization is described as first sharing tacit knowledge and then making it explicit (Nonaka and Takeuchi, 1995) – thus even the definition of this knowledge conversion (externalization) includes socialization. Tuomi (1999) has pointed out the overlap and difficulty to separate the four knowledge conversions from each other.

The greatest differences between the theory presented by Nonaka et al. (1998, 2000) and the results of the study were in the context – 'ba' – in which the knowledge conversions took place. This was especially emphasized in combination and internalization stages. Nonaka et al. (1998, 2000) have claimed that 'cyber ba' with virtual interactions is the context which supports and speeds up combination. However, in this study teams working in open space doing software design and real estate strategy and process development work utilized effectively face-to-face

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communication in information search and experienced face-to-face communication enhancing and making their working easier. According to these results, even though virtual interaction is necessary in global work teams, virtual interactions without face-to-face communication may not be the most effective context even for combination as compared to a choice to combine both virtual and face-to-face interactions.

Similarly, some of internalization was a result of on-the-site experiences and learning by doing taking place in 'exercising ba', but self-reflection or reflection with others were also important aspects of internalization in each knowledge work studied. Part of the internalization was characterized by individual and virtual interactions (Nonaka, Toyama and Konno, 2000) but especially in software design and real estate strategy and process development work it also happened collectively and face-to-face with others.

Furthermore, even though the relationship between 'ba' and the knowledge conversion it mainly supports is not claimed to be exclusive (Nonaka et al., 2000), building and supporting the four suggested 'ba' are not necessarily sufficient 'ba' for the knowledge conversions to take place efficiently. For example, in 'originating ba', which mainly offers a context for socialization, individuals share experiences, feelings, emotions and mental models in face-to-face interaction (Nonaka et al., 2000). This corresponds to the socialization methods such as shared experiences (Nonaka, 1994), joint activities like being together and spending time together as well as physical proximity (Nonaka and Konno, 1998). However, methods like apprenticeship including observation, imitation and practice (Nonaka, 1991) and on-the-job training (Nonaka, 1994) are also important methods for sharing tacit knowledge in organizations. Even though 'originating ba' supports these methods it is not merely a sufficient context for e.g. apprenticeship. In apprenticeship and on-the-job training besides just sharing experiences, feelings, emotions and mental models in face-to-face interaction some structure and goals would probably be valuable characteristics as well.

Finally, the path from individual knowledge to organizational one introduced by Nonaka (1994) could be elaborated by utilizing the framework presented by Crossan et al. (2000). The results of the study seemed to support the process of intuiting, interpreting, integrating and institutionalization (Crossan et al., 2000) rather than enlargement of an individual's knowledge,

sharing tacit knowledge and conceptualization, crystallization and justification of the knowledge (Nonaka, 1994). Thus, the knowledge creation seemed to start from an individual exploiting his/her previous knowledge in new situations and generating new insights and connections. Following, these ideas were articulated either alone or with help of others. Then, according to the framework (Crossan et al., 2000) a shared understanding is supposed to be created through dialogue. This happened in three of the cases in which socialization was common. Finally, the knowledge is internalized into organizational routines. As the focus of the study was on individual and group level, this last process of institutionalization was out of the scope of the study.

#### 4.1.1 Emphasis of different knowledge conversions

The emphasis and meaning of different knowledge conversions (sharing tacit knowledge, converting tacit knowledge to explicit one, combining explicit knowledge and internalizing explicit knowledge) differed between the knowledge works studied. This seemed to depend on the contents of the work. In the real estate strategy and process development work (case D), socialization (sharing tacit knowledge, feelings and emotions) was most emphasized as the relationships with customers and partners were given a great value. This may imply that in work where the quality of relationships – either internal or external – is in significant role, probably also socialization should prevail. Accordingly, socialization played overall a considerable role in the knowledge works studied where the work was team work, and was almost lacking in the software research work in which the work took place individually. Furthermore, socialization plays a role in making not only the explicit knowledge but also the rich tacit knowledge of individuals available to others (Nonaka, 1994), and thus would be worth nurturing in order to enrich the organizational knowledge of companies.

In software research work (case C), on the other hand, externalization (converting tacit knowledge into explicit) was most emphasized. The focus of work was on recognizing opportunities for new products and idea formulation. Thus, in this kind of R&D work it would probably be even desired, that the emphasis of work processes would be on externalization whilst the other knowledge conversions playing more minor roles. However, externalization combined with socialization may provide the most efficient way of creating high-quality

knowledge in the organizations (Chua, 2002). In case B doing software design work, externalization was an important process and was usually combined with socialization. Overall, case B was a part of a successful and innovative software company which may reflect the existence of both socialization and externalization in their work processes.

Combination of explicit knowledge was an important process in each knowledge work studied. It was especially emphasized in software design work in the global company (case A). Their work was based on utilizing existing codes and methods. As compared to the software design work in the smaller software company (case B), the work in the smaller company involved more ideation and planning, as in the global company the requirements of the software were given ready to the designers. Combining existing explicit knowledge e.g. from different disciplines or applications provides a decent source for new knowledge and even innovations. Thus, in work in which knowledge is to a great extent articulated and codified in explicit form, combination may be a key process also in knowledge creation.

Internalization was also important in each knowledge work studied. Internalization was the process through which the knowledge workers deepened their expertise. It was also an important process in understanding the task at hand and the requirements of the customer. Internalization should probably be supported in all kinds of knowledge works requiring *understanding* of the contents of the work.

#### 4.1.2 Knowledge conversion methods in knowledge work

Besides the emphasis of different knowledge conversions varying between the knowledge works studied, also the ways of accomplishing these conversions differed. Overall, in software design work and real estate strategy and process development work face-to-face communication and interaction with others were much more emphasized than in software research work. In the software research work studied, work was done individually and communication took place mainly virtually.

Common ways for socialization were working together, spending time together, having lunch and coffee together and having some sports or other leisure activities together. These were emphasized in software design work and real estate strategy and process development work. In ways of externalization, there were clear differences between the knowledge works studied. In real estate strategy and process development work, this was most clearly a group activity: externalization took place in meetings and stimulating discussions or as working and sparing with a pair. In the software design work studied in the small company (case B), externalization took place also a lot in groups of different sizes but many times alone, too. Characteristic of externalization in this software design work was extensive use of papers and pens, post-it slips and white boards to sketch the ideas on wall or paper. On the contrary, in the software research work studied, externalization was clearly an individual activity and did not necessarily involve any other persons than the researcher him/herself. In the software design work studied in the global company (case A), problems were solved also together but usually externalization was a result of intensive individual concentration.

Ways of combination were quite similar in software design work and real estate strategy and process development work. IT was utilized effectively and information was searched from databases and Internet. Books, articles and magazines were also used. These were also characteristic ways of combination in the software research work studied. However, in the software design work and real estate strategy and process development work face-to-face communication was used effectively in combination. They could easily ask information from their colleagues, deliver ideas or information instantly and they could hear discussions of other people while they were working. Internalization was both an individual and social process in software design work and real estate strategy and process development work, but in the software research work studied it was clearly an individual process.

As discussed earlier, the more social ways of working make the rich tacit knowledge of individuals available to others in the organization and may enhance the quality of knowledge creation. Thus, managers may be willing to encourage working together and sharing experiences with other people, if tacit knowledge constitutes a significant part of the work. Furthermore, even if the work is mainly based on explicit knowledge, face-to-face communication may enhance the information search and deliver notably.

According to the results of the study, the social ways of working were facilitated by team work vs. individual work, working in an open space instead of separate offices, and having a culture

supporting social interaction with colleagues. When knowledge workers work in teams they have a need for social interaction with others to accomplish their job. However, team work can also be separated into individual tasks, and without supporting culture, team work may also take rather individual forms. In this study, working in open space enhanced communication and working with others particularly when it was combined with a culture of having lunch and coffee breaks together as well as having other activities like sports and social events uniting the people together.

## 4.2 Contributions of the study

The knowledge conversion processes of different kinds of knowledge works were analyzed and presented in detail in this study. As a result of the study, the knowledge conversions could be described vividly and systematically in the knowledge works studied. In consequence of the analysis, new insights could be united to the model presented by Nonaka et al. Thus, new nuances were found in the knowledge conversions as a result of the study.

New knowledge was also derived from how the knowledge conversions were actually realized in the knowledge works. All the knowledge conversions could be identified in each knowledge work studied. However, the emphasis and the methods for the knowledge conversions varied across the knowledge works. Implications of these variations were discussed.

Overall, Nonaka et al. (Nonaka, 1991; 1994; Nonaka et al., 1994; Nonaka and Takeuchi, 1995; Nonaka and Konno, 1998; Nonaka, Toyama and Konno, 2000; Nonaka, Toyama and Nagata, 2000) have made a significant effort on describing the methods for the four knowledge conversions. Accordingly, no new and exceptional methods emerged in carrying out the knowledge conversions across the knowledge works studied. The results of the study made the description of these processes even more vivid and concrete. However, the knowledge conversions were not typically carried out in the corresponding 'ba' suggested by Nonaka et al. (1998, 2000). This raises a question, whether the 'ba' Nonaka et al. suggest really are the most suitable and effective ones for each knowledge conversion.

Furthermore, implications were derived from the results of the study that Crossan, Lane and White's (2000) framework of organizational learning for strategic renewal might give some

additional insights in conceptualizing the conversion of individual knowledge creation into organizational one. The process of intuiting, interpreting and integrating fitted better to the results of the study than the original idea of enlargement of an individual's knowledge, sharing tacit knowledge and conceptualization, crystallization and finally justification of the knowledge of Nonaka (1994).

Besides the theoretical contributions, the study provided also new insights for managers to improve the conditions for knowledge creation in their organizations. Understanding the knowledge conversions embedded in the knowledge creation process enables managers to provide settings and circumstances needed for knowledge creation. The managers should decide, which knowledge conversions are critical for accomplishing certain tasks and which ways of carrying these out the company wants to support.

### 4.3 Validity and reliability of the study

In assessing the results of the study, reliability and validity of the study should be dissected. The validity of the research can be improved by using triangulation (Patton, 1999; Jick 1979). Triangulation means that the phenomenon is examined using different kinds of methodologies: "The logic of triangulation is based on the premise that no single method ever adequately solves the problem of rival explanations. Because each method reveals different aspects of empirical reality, multiple methods of data collection and analysis provide more grist for the research mill." (Patton, 1999, p. 1192). Triangulation can be e.g. methods triangulation, triangulation of sources, investigator triangulation and theory/perspective triangulation.

In this study, triangulation of methods, sources and investigators were used to enhance the validity of the study. Three different kinds of qualitative methods were used in the study: individual interviews, group interviews and observation. In individual interviews, the interviewees described their work and work processes as they perceived them themselves. As the work contained knowledge creation as an inherent part of the job, these processes also reflected the knowledge conversions embedded in their work. Following, valuable knowledge of everyday work embedded in different knowledge conversions was derived from the individual interviewees even though the interviewees would not have necessarily perceived

these work processes being related to knowledge conversions and knowledge creation if it would have been requested directly.

Group interviews and observations were used to complement the picture of the knowledge conversions derived from the individual interviews. In group interviews, the interviewees were asked to analyze the knowledge conversions in their work themselves in the frame of the SECI process. The names of the knowledge conversions (socialization, externalization etc.) were not used but the conversions were explained to the interviewees in other words. In the group interview e.g. the emphasis of different knowledge conversions was evaluated by the interviewees and they were also asked to comment the impressions the researchers had got of their work. Thus, the group interviews provided new aspects of the knowledge conversions and were also used to validate the findings from the individual interviews. However, explaining the knowledge conversions among the interviewees as they may have understood the conversions differently than was meant. Following, this was taken into account when analyzing the data.

Observations were used to confirm the data from the interviews. As the interviewees considered certain issues self-evident and did not describe these issues in the interviews, the researchers could experience the ways of interacting and doing the everyday work by being present and observing the climate in the case sites. Observation provided data mostly on whether the software designers, researchers and real estate specialists worked alone or together with others, what kind of interaction they had going on during their working day and where their work took place when they were present.

Triangulation of sources took place by comparing the individual interviews with the data from group interviews and observations. Furthermore, triangulation of investigators was put into practice in three ways. First, two researchers were present in all interviews and both researchers did observations one at a time. Impressions of the interviews and observations were discussed between the researchers. Second, the researchers' impressions of the cases were presented to the interviewees after the observation period and were discussed with the interviewees. In addition, the results of the analysis were sent to the interviewees to be commented. Third, the research and analysis process as well as the results of the study were presented and discussed in the

management group meetings consisting of representatives of the case companies. Triangulation of investigators is also called 'face validity' which is the main way of validating content analysis (Kyngäs, 1999).

One necessary condition for validity is the reliability of the study. The reliability of the study has been facilitated by having two researchers with different backgrounds gathering the data (Patton, 1999). The researchers were from different disciplines than the interviewees, which forced them making detailed questions to understand the phenomena instead of taking certain issues self-evident without asking further questions (cf. Alasuutari, 1993). The researchers gave feedback to each other on the interviewing process, and special attention was paid to avoiding leading questions in the interviews. The interview situations were open and confidential and were held, except of two individual interviews, in private meeting rooms. The interviewees normally described their work eagerly and confidentially keeping to the subject, which can be considered as criteria of a successful interview.

All the interviews were recorded and later transcribed. Field notes were made of the impressions emerged during the research process. The analysis of the data was systematical content analysis of the transcribed interviews (cf. Mäkelä, 1992).

Reliability of the study is also related to the credibility of the researcher. Issues to be considered are e.g. the experience, training, and perspective the researcher brings to the field; the personal connections the researcher has to the people or topic studied; the financiers of the study and the arrangements made with the researcher; and how the researcher got access to the study site (Patton, 1999). In this study following issues may have affected the data gathering, analysis and results of the researcher in projects concerning knowledge management and especially sharing of tacit knowledge. This may cause a bias towards focusing on 'human' issues at the expense of e.g. more technical issues. As a psychologist the author has been trained to separate one's own reactions from those of the other party. This may have compensated the relatively little experience with research work of the author in accordance to the reliability of the data.

# 4.4 Limitations of the study

The research approach in this study was descriptive qualitative case study which brings along certain limitations. Firstly, as the approach was descriptive, the results do not provide any causal relationships between different variables. Rather, the aim was to describe the knowledge conversions in different kinds of knowledge works to increase the understanding of these processes in real context. Secondly, the qualitative research methodology and the case study approach set limits to the generalizability of the results. Access to the research sites was got due to the networks of the research project manager and the interest of the managers of the case sites in the topics of the research. Selecting different kinds of knowledge works than was studied in this research may have led to more representative sample of knowledge works studied were not necessarily representative of knowledge conversions in knowledge work in general. Furthermore, the quality of knowledge creation in the cases was not measured. Thus, it cannot be stated which cases illustrated effective knowledge creation if any.

Further, the interviewees were let to describe their work in their own terms in the thematic interviews. Following, there might have been issues related to the subject that the interviewees did not bring into discussion for some reason. For example, there might be reason to suppose that the young designers were chatting in Internet about subjects that also enhanced their working and knowledge conversions. However, the interviewees may have assumed the chatting as irrelevant or even inappropriate for their work, and did not elicit the issue when describing processes related to their work. Furthermore, the specifying questions made by the interviewers may have been biased highlighting some issues while leaving some issues untreated.

Furthermore, in some of the cases the interviewees described their work more vividly than in others. The reasons for this might have lied in the content of their work, in their ability to describe their work in words or in the interviewing process itself. The interviewing sessions, however, were attempted to be made consistent across cases and provide an open and confidential atmosphere for the discussions.

Some limitations in interpreting the data may have caused also the background of the researcher. As a psychologist the author is not personally familiar with software design, research or real estate strategy and process development work. This may have caused hazards when categorizing and judging the work processes described into different knowledge conversion categories with only surface knowledge of the work itself. However, as Alasuutari (1993) has pointed out, it might be even an advantage to be a total outsider to be able to ask enough questions on the subject without taking certain things for granted.

Overall, descriptive qualitative case study was a suitable approach for studying a relatively new and complex phenomenon in its real context. With quantitative methods more generalizable results could have been received, but quantitative methods could not have captured the richness and variety of the knowledge conversion processes illustrated in the study.

# 4.5 Conclusions

To conclude, in light of the results of the study, the emphasis of different knowledge conversions seems to be depending on the contents of the knowledge work and hence on the kind of knowledge work at issue. However, the ways of carrying out the knowledge conversions seem to be more dependent on other factors like team vs. individual work, working culture, workspace arrangements and other organizational enablers than the kind of knowledge work at hand.

The work in all cases studied was clearly knowledge work in which working with knowledge was the primary activity and high skill and expertise were needed. However, the software design work in the global company had many similarities with the highly specialized, standardized and controlled work in machine bureaucracies. On the other hand, the software research work in the same company had similarities with the professional bureaucracy with the individualistic theoretical and abstract knowledge of highly trained individual experts and little redundancy of knowledge and co-operation between the experts. Whilst the global organization of which both software design and research work were part could be classified as the kind of J-form organization, the results imply that these kinds of organizations may contain different kinds of knowledge works – some with more specialized, standardized and controlled features. These findings support the idea of mechanistic, organic and dynamic layers (Ståhle and

Grönroos, 2000) of knowledge organizations. However, certain type of software design work may be a part of the mechanistic layer of an organization, but presumably software research work should rather belong to the dynamic layer than the mechanistic layer of an organization.

Accordingly, Lam's (2000) distinction of organizations according to their dominant knowledge types seems to be a consequence of the different methods of carrying out the knowledge conversions. As the current trend of organizations is towards J-type organization in which knowledge resides in operating routines, team relationships and shared culture (Blackler, 1995), the knowledge conversions should be carried out in such a way that in the organic and dynamic layers of organizations the collective tacit knowledge becomes the prevailing type of knowledge. This requires the more social ways of carrying out the knowledge conversions.

As can be expected, some issues were left unanswered in this study. To derive more generalizable conclusions and to develop and back up the knowledge creation theory with empirical evidence, the research should be extended to compare more kinds of knowledge works to each other. Also, this study was delimited to study the knowledge conversions on individual and group levels. Overall, the SECI process is considered to be best suited to study the knowledge conversions in this level (Tuomi, 1999). When applied to organizational level, the SECI process has been criticized as taking shared language and culture within a company as given (Tuomi, 1999). In reality, different communities of practice create their own language and culture. It is not clear what happens to the SECI spiral when it hits the boundaries of different communities of practice existing in the organization. Furthermore, the justification in knowledge creation was left outside the scope of the study. Von Krogh and Grand (2000) have emphasized the importance of and pushed forward research on this aspect of knowledge creation.

Furthermore, new questions arose during the study concerning the knowledge conversions themselves. There seems to be some incongruity between the description of the knowledge conversions and 'ba': the methods for carrying out the knowledge conversions across the knowledge works studied were almost congruent with the methods introduced by Nonaka et al. for socialization, externalization, combination and internalization. Nevertheless, the knowledge conversions did not take place merely in the corresponding 'ba' in any of the knowledge works

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studied. According to Nonaka and Konno (1998) 'ba' offers a platform for knowledge conversions, and the certain types of 'ba' speed up the process of knowledge conversion. Thus, while they present a lot of methods for the knowledge conversions, they strongly prefer e.g. collaborative environments utilizing IT for combination or dialoguing for externalization. It is controversial, however, whether the 'ba' suggested by Nonaka et al. are really the most effective and desirable ones for organizational knowledge creation. This question would require further research.

Overall, the model of knowledge creation has evoked great interest both among academics and practitioners. Perhaps after a decade or two, the ongoing research on knowledge creation is ready to be converged, and a robust theory on knowledge creation might be created. The words of von Krogh (1998) capture the conclusion of this study: "Bear in mind that what will make or break the transformation into a "knowledge-creating company" will not be the overall structural approaches of "managing knowledge", but your sensitivity to the way people relate."

# References

#### Alasuutari, P. (1993) Laadullinen tutkimus. Tampere: Vastapaino. (in Finnish)

- Aoki, M. (1988) Information, Incentives and Bargaining in the Japanese Economy. Cambridge: Cambridge University Press.
- Binney, D. (2001) The Knowledge Management Spectrum Understanding the KM Landscape, Journal of Knowledge Management, Vol. 5 (1), pp. 33-42.
- Blackler, F. (1995) Knowledge, Knowledge Work and Organizations: An Overview and Interpretation, Organization Studies, Vol. 16 (6), pp. 1021-1046.
- Blumentritt, R. and Johnston, R. (1999) Towards a Strategy for Knowledge Management, Technology Analysis & Strategic Management, vol. 11 (3), pp. 287-300.
- Brown, J. and Duguid, P. (1991) Organizational Learning and Communities-of-Practice: Toward a Unified View of Working, Learning and Innovation, Organization Science, Vol. 2 (1), pp. 40-57.
- Brown, J. and Duguid, P. (1998) Organizing knowledge, California Management Review, vol. 40 (3), pp. 90-111.
- Bryman, A. (1989) Research Methods and Organization Studies. NY: Routledge.
- Castells, M. (1996) The Rise of the Network Society. Vol. I of the Information Age. Economy, Society and Culture. Oxford: Blackwell.
- Christopher, M. (1998) Logistics and Supply Chain Management. Strategies for Reducing Cost and Improving Service. London: Pearson Education Limited.
- Chua, A. (2002) The Influence of Social Interaction on Knowledge Creation, Journal of Intellectual Capital, vol. 3 (4), pp. 375-392.
- Collins, H. (1993) The Structure of Knowledge, Social Research, Vol. 60, pp. 95-116.

- Collins, D. (1997) Knowledge Work or Working Knowledge? Ambiguity and Confusion in the Analysis of the "Knowledge Age", Employee Relations, Vol. 19 (1), pp. 38-50.
- Creswell, J. (1994) Research Design: Qualitative & Quantitative Approaches. Thousand Oaks: SAGE.
- Crossan, M., Lane, H. and White, R. (1999) An Organizational Learning Framework: From Intuition to Institution, Academy of Management Review, Vol. 24 (3), pp. 522-537.
- Davenport, T., Järvenpää, S. & Beers, M. (1996) Improving Knowledge Work Processes, Sloan Management Review, Summer, pp. 53-65.
- Davenport, T. and Prusak L. (1998) Working knowledge. Boston (Mass.): Harvard Business School Press.
- Despres, C. & Hiltrop, J.M. (1995) Human Resource Management in the Knowledge Age: Current Practice and Perspectives on the Future, Employee Relations, Vol. 17 (1), pp. 9-23.
- Dretske, F. (1981) Knowledge and the Flow of Information. Cambridge, MA: MIT Press.
- Drucker, P. (1988) The Coming of the New Organization, Harvard Business Review, January-February, pp. 45-53.
- Drucker, P. (1991) The New Productivity Challenge, Harvard Business Review, November-December, pp. 69-79.
- Drucker, P. (1999) Knowledge Workers Productivity: The Biggest Challenge, California Management Review, Vol. 41 (2), pp. 79-94.
- Forster, N. (2000) The Potential Impact of Third-Wave Technologies on Organizations, Leadership & Organization Development Journal, Vol. 21 (5), pp. 254-263.
- Grant, R. (1996) Prospering in Dynamically Competitive Environments: Organisation Capability as Knowledge Integration, Organizational Science, Vol. 7 (4), pp. 375-387.

- Hansen, M., Nohria, N. and Tierney, T. (1999) What's Your Strategy for Managing Knowledge? Harvard Business Review, March-April, pp. 106-116.
- Hardagon, A. (1998) Firms as Knowledge Brokers: Lessons in Pursuing Continuous Innovation, California Management Review, Vol. 40 (3), pp. 209-227.
- Hope, J. and Hope, T. (1997) Competing in the Third Wave: The Ten Key Management Issues of the Information Age. Boston: Harvard Business School Press.
- Hustad, W. (1999) Exceptional Learning in Knowledge Communities, Journal of Organizational Change Management, Vol. 12 (5), pp. 405-418.
- Ingelgård, A., Roth, J., Shani, A.B. and Styhre, A. (2002) Dynamic Learning Capability and Actionable Knowledge Creation: Clinical R&D in a Pharmaceutical Company, The Learning Organization, Vol. 9 (2), pp. 65-77.
- Jick, T. (1979) Mixing Qualitative and Quantitative Methods: Triangulation in Action, Administrative Science Quarterly, Vol. 24, pp. 602-611.
- Kelley, R.E. (1990) Managing the New Workforce, Machine Design, Vol. 10, May, pp. 109-113.
- Kogut, B. and Zander, U. (1996) What Firms Do? Coordination, Identity and Learning, Organization Science, Vol. 7, pp. 502-518.
- Krippendorff, K. (1980) Content Analysis. An Introduction to Its Methodology. Newbury Park: SAGE.
- Kulkki, S. (1999) Knowledge Creation of Multicultural Corporations Knowledge Creation through Action. Helsinki School of Economics and Business Administration, Acta Universitatis Oeconomicae Helsingiensis, A-115. Helsinki.
- Kyngäs, H. (1999) Content Analysis as a Research Method, Journal of Nursing Science, Vol. 11 (1), pp. 3-12. (in Finnish)

Lam, A. (2000) Tacit Knowledge, Organizational Learning and Societal Institutions: An Integrated Framework, Organization Studies, Vol. 21 (3), pp. 487-513.

Lammenranta, M. (1993) Tietoteoria. Tampere: Gaudeamus. (in Finnish)

- Matusik, S. and Hill, C. (1998) The Utilization of Contingent Work, Knowledge Creation, and Competitive Advantage, The Academy of Management Review, Vol. 23 (4), pp. 680-697.
- Millar, J., Demaid, A. and Quintas, P. (1997) Trans-organisational Innovation: A Framework for Research, Technology Analysis & Strategic Management, Vol. 9 (4), pp. 399-418.
- Mintzberg, H. (1979) The Structure of Organizations. Englewood Cliffs, NJ: Prentice Hall.
- Mäkelä, K. (eds.) (1992) Kvalitatiivisen aineiston analyysi ja tulkinta. Helsinki: Gaudeamus.
- Nahapiet, J. and Ghoshal, S. (1998) Social Capital, Intellectual Capital, and the Organizational Advantage, Academy of Management Review, Vol. 23, pp. 242-266.
- Nishida, K. (1970) Fundamental Problems of Philosophy: The World of Action and the Dialectical World. Tokyo: Sophia University.
- Nobeoka, K. and Baba, Y. (2001) The Influence of New 3-D CAD Systems on Knowledge Creation in Product Development. In: Knowledge Emergence, eds. Nonaka, I. and Nishiguchi T., New York: Oxford University Press.
- Nomikos, G.E. (1989) Managing Knowledge Workers for Productivity, National Productivity Review, Vol. 8 (2), pp. 165-174.
- Nonaka, I., (1991) The Knowledge-Creating Company, Harvard Business Review, November-December, pp. 1-9.
- Nonaka, I. (1994) A Dynamic Theory of Organizational Knowledge Creation, Organization Science, Vol. 5 (1), pp. 14-37.

- Nonaka, I., Byosiere, B., Borucki, C. and Konno, N. (1994) Organizational Knowledge Creation Theory: A First Comprehensive Test, International Business Review, vol. 3 (4), pp. 337-351.
- Nonaka, I. and Takeuchi, H. (1995) The Knowledge-creating Company: How Japanese Companies Create The Dynamics of Innovation. New York: Oxford University Press.
- Nonaka, I. and Konno, N. (1998) The Concept of "Ba": Building a Foundation for Knowledge Creation, California Management Review, Vol. 40 (3), pp. 40-54.
- Nonaka, I., Toyama, R. and Konno, N. (2000) SECI, Ba and Leadership: a Unified Model of Dynamic Knowledge Creation, Long Range Planning 33, pp. 5-34.
- Nonaka, I., Toyama, R. and Nagata, A. (2000) A Firm as a Knowledge-creating Entity: A New Perspective on the Theory of the Firm, Industrial and Corporate Change, Vol. 9 (1), pp. 1-20.
- Nonaka, I, Konno, N. and Toyama R. (2001) Emergence of "Ba": A Conceptual Framework for the Continuous and Self-Transcending Process of Knowledge Creation. In: Knowledge Emergence, eds. Nonaka, I. and Nishiguchi T., New York: Oxford University Press.
- Nonaka, I. and Toyama, R. (2002) A Firm as a Dialectical Being: Towards a Dynamic Theory of a Firm. Industrial and Corporate Change, vol. 11 (5), pp. 995-1009.
- Orr, J. (1996) Talking About Machines: An Ethnography of a Modern Job. Ithaca, NY: ILR Press.
- Pan, S. and Scarbrough, H. (1999) Knowledge Management in Practice: An Exploratory Case Study, Technology Analysis & Strategic Management, Vol. 11 (3), pp. 359-374.
- Patton, M. (1999) Enhancing the Quality and Credibility of Qualitative Analysis, Health Services Research, Vol. 34 (5), pp. 1189-1208.
- Polanyi, M. (1966) The Tacit Dimension. London: Routledge & Kegan Paul.

- Prahalad, C. and Hamel, G. (1990) The Core Competence of the Corporation, Harvard Business Review, Vol. 68 (3), pp. 79-91.
- Pyöriä, P. (2001) Tietotyössäkö tulevaisuus? Hyvinvointikatsaus 1/2001. (in Finnish)
- Raunio, K. (1999) Positivismi ja ihmistiede. Helsinki: Gaudeamus. (in Finnish)
- Robson, C. (1993) Real World Research. A Source for Social Scientists and Practitioner-Researchers. Oxford: Blackwell.
- Roth, J. (2003) Enabling Knowledge Creation: Learning from an R&D Organization, Journal of Knowledge Management, Vol. 7 (1), pp. 32-48.
- Salisbury, M. (2001) An Example of Managing the Knowledge Creation Process for a Small Work Group, Management Learning, Vol. 32 (3), pp. 305-319.
- Scarbrough, H. (1999) Knowledge as Work: Conflicts in the Management of Knowledge Workers, Technology Analysis & Strategic Management, Vol. 11 (1), pp. 5-16.
- Scharmer, C. (2001) Self-Transcending Knowledge: Organizing Around Emerging Realities. In: Managing Industrial Knowledge, Creation, Transfer and Utilization, eds. Nonaka, I. And Teece, D., London: Sage Publications.
- Sharkie, R. (2003) Knowledge Creation and Its Place in the Development of Sustainable Competitive Advantage, Journal of Knowledge Management, Vol. 7 (1), pp. 20-31.
- Shimizu, H. (1995) Ba-Principle: New Logic for the Real-Time Emergence of Information, Holonics, Vol. 5 (1), p. 67-79.
- Spender, J. (1996) Making Knowledge the Basis of the Dynamic Theory of the Firm, Strategic Management Journal, Vol. 17 (Winter Special Issue), pp. 45-62.
- Stacey, R. (2001) Complex Responsive Processes in Organizations Learning and Knowledge Creation. London: Routledge.

- Starbuck, W. (1992) Learning by Knowledge-Intensive Firms, Journal of Management Studies, Vol. 29 (6), pp. 713-740.
- Starbuck, W. (1993) Keeping a Butterfly and an Elephant in a House of Cards: The Elements of Exceptional Success, Journal of Management Studies, Vol. 30, pp. 885-922.
- Ståhle, P. and Grönroos, M. (2000) Dynamic IC: Knowledge Management in Theory and Practice. Helsinki: WSOY.
- Sutton, R. and Hargadon, A. (1996) Brainstorming Groups in Context: Effectiveness in a Product Design Firm, Administrative Science Quarterly, Vol. 41, pp. 695-718.
- Sveiby, K.-E. (2001) A Knowledge-Based Theory of the Firm to Guide in Strategy Formulation, Journal of Intellectual Capital, Vol. 2 (4), pp. 344-358.
- Sveiby, K.-E. and Lloyd, T. (1987) Managing Knowhow: Add Value by Valuing Creativity. London: Bloomsbury.
- Tesch, R. (1990) Qualitative Research: Analyses Types and Software Tools. London: Falmer.
- Thomke, S. (2001) The Impact of Technology on Knowledge Creation: A Study of Experimentation in Integrated Circuit Design. In: Knowledge Emergence, eds. Nonaka, I. and Nishiguchi, T., New York: Oxford University Press.
- Toffler, A. (1983) Previews and Premises. New York: Black Rose Books.
- Tilastokeskus (1997) Tiedolla yhteiskuntaan. Helsinki, Tilastokeskus. (in Finnish)
- Tilastokeskus (1999) Tiedolla yhteiskuntaan II. Helsinki, Tilastokeskus. (in Finnish)
- Tuomi, I. (1999) Corporate Knowledge Theory and Practice of Intelligent Organizations. Helsinki: Metaxis.
- Turvani, M. (2001) Microfoundations of Knowledge Dynamics within the Firm, Industry and Innovation, Vol. 8 (3), pp. 309-323.

- Von Krogh, G. (1998) Care in Knowledge Creation, California Management Review, Vol. 40 (3), pp. 133-153.
- Von Krogh, G. and Grand, S. (2000) Justification in Knowledge Creation: Dominant Logic in Management Discourses. In: Knowledge Creation. A Source of Value, eds. von Krogh, G., Nonaka, I. and Nishiguchi, T, Houndmills: MacMillian Press LTD.
- Von Krogh, G., Ichijo, K. and Nonaka, I. (2000) Enabling Knowledge Creation. How to Unlock the Mystery of Tacit Knowledge and Release the Power of Innovation. Oxford: Oxford University Press.
- Wenger, E. and Snyder, W. (2000) Communities of Practice: The Organizational Frontier, Harvard Business Review, January-February, pp.139-145.
- Yin, R. (1993) Applications of Case Study Research. Newbury Park: Sage Publications.
- Yin, R. (1994) Case Study Research, Design and Methods. Thousand Oaks: Sage.
- Zack, M. (1999) Developing a Knowledge Strategy, California Management Review, Vol. 41 (3), pp. 125-145.

# APPENDIX 1. Semi-structured individual interviews.

In the beginning of the interview the researchers told that they were from Helsinki University of Technology, TAI Research Centre, and explained who the participants and financiers of the study were. The aim of the study was told to be to get acquinted with the interviewee's work, and how he/she worked, and how the interviewee perceived his/her work and the working environment and the processes of his/her work in order to be able to decide how the facilities could be improved to support the work better<sup>3</sup>. The interviewees were told that the interviews were confidential and would not necessarily change their own working facilities, but that the company in which they worked was interested in how it could improve its facilities to enhance the work done in the company.

Background information asked from the interviewee (not necessarily in this order):

- name
- age
- education
- work history
- work history in the current company
- overall description of the current job

Main question: Would you describe us your work, what is it that you do for your work, how do you perceive your work and working process? Could you make us some kind of drawing or chart of your work? What is the process like?

Examples of possible specifying questions if the interviewee did not bring the issues up him/herself:

- Are there some different kinds of phases in your work?
- Could you describe more what you mean by this (pointing to some part of the drawing)?
- If this is what you do (pointing to some part of the drawing), could you tell us how you do it?
- Could you think about what are the outputs of your work? Could you describe what the process of getting these outputs is like?
- Are there some other persons involved in your work? How? How do you work together? How do you communicate?
- Now you told us that you have these meetings. Could do tell us more what these meetings are like?
- Could you tell us what your typical working day is like?
- Are you in contact with other people during your working day? How?

<sup>&</sup>lt;sup>3</sup> This was actually the subject of the doctoral dissertation of M.Sc. Marja Kauttu.

APPENDIX 2. Group interview.

Instructions for the group interview:

Now, I want you to force yourself to classify the work that is done here into four categories (the researcher putting simultaneously the phrases representing the four knowledge conversions across the wall):

- Trying to understand the other's way of thinking, sharing mental models. It means you want to find out how the other person is thinking and what his way of thinking is and really want to understand. Maybe share some experiences. This can also happen by watching a very experienced worker and see how he works.

- Crystallizing fuzzy thoughts, translating implicit ideas into explicit form. It means that you have something quite intuitive and fuzzy ideas and you have to make it into a kind of explicit form, you try to put it into words.

- Refining and systemizing explicit knowledge. So you got the knowledge and you just utilize it: you may combine it or refine it or systematize it. It means that you got to work with existing knowledge; with explicit knowledge that is written or worded.

- Internalizing, implementing into own working habits. This means understanding. This may be like learning by doing. You try to get it inside yourself.

So, now you should decide, how much each of these categories is involved in your work, so that the sum of the percentages would be 100 %. Also tell us, which work tasks you would put into each category.







systemizing explicit knowledge



Figure 8. Phrases for knowledge conversions used in the group interviews.