ACQUISITION OF COMPETENCES IN THE WORKPLACE

Human resource development in Statoil

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SUMMARY

This research is designed to investigate three related propositions about the acquisition of competences in work organizations. The first proposition is that learning results from exposure to information (accumulation effects). The second proposition claims that the effect of information wears off and that accumulation of information eventually ceases to have an effect on competences (diminishing effects). The final proposition claims that exposure to a specific source or type of information has different effects on different competence outcomes (differential effects).

Three firm-specific competences were identified as relevant outcomes of learning in organizations. Intraorganizational competence is the non-technical competence which regards the organization as a whole. Intraunit competence is the non-technical competence specific to one organizational unit. Firm-specific technical competence is both firm and task specific and applies to a small set of tasks within the organization. For each of the three propositions, a set of hypotheses were developed relating job history, organizational structures and communication to each of the competence outcomes.

The research reported here addresses three notable shortcomings in previous research on learning in organizations. First, the research investigates the actual competence outcomes of learning (as opposed to performance outcomes). Second, the research distinguishes among different work-related competences as well as their antecedents. Third, the research specifies the notion of experience at a conceptual rather than operational level.

Hypotheses were tested on data obtained from 981 employees in Statoil, the major Norwegian oil company. Twelve of 22 hypotheses relating to the first proposition were supported. Inadequate measurement of explanatory variables may explain why four of the hypotheses were not supported by the results. Four of five hypotheses relating to the second proposition were supported, whereas only two of ten hypotheses regarding the third proposition were supported. Intraorganizational job history and communication appear to have large, positive and diminishing effects on firm-specific competences. Further research is needed to clarify the impact of organizational structures. The research reported here further supports the claim that exposure to information should replace the notion of experience as an explanation of learning. Although the idea of differential effects obtained limited support, this research demonstrates that different competences can be distinguished empirically.

PREFACE

This is the end of a journey that started several years ago. Originally trained as a mechanical engineer, it may indeed seem strange that I ended up studying the software and not the hardware of business organizations.

The path from a broad and general idea to rigorous empirical research is long and frustrating. First of all I have to thank Torger Reve for getting me on the track and pulling me down to the ground. I have to thank Statoil, the Norwegian state oil company, for providing financial support and access to a large and rich empirical setting. Numerous persons inside Statoil were most helpful during pilot study and main study. Most important were of course my liaison officers Nickey Berg and Einar Brandsdal. Thanks to Gunnar Rune Løland, Alf Orheim and Lillemor Sjøtun at Statoil for taking care of some crucial practical details. Jan Roar Nordli and Eirik Oppen at Statoil Bergen and Johnny Mostraum at Opinion AS did the computer wizardry needed get the data collection done in a surprisingly short time. The Foundation for Research in Economics and Business Administration supported the completion of this thesis.

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Responsibility for shortcomings, omissions and errors rests with the author.

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CONTENTS

1. INTRODUCTION

1.1 Purpose

The purpose of this thesis is to test the proposition that exposure to work-related domains generates domain-specific competences. Empirical research on informal learning in the workplace has generally been concerned with the effect of experience (in terms of tenure or cumulative output volume). This study generalizes the notion of experience into a concept of exposure to work-related information, and differentiates this information according to the work-related domain to which the employee is exposed. In this context, information is defined as sense data. Three types of firm-related domain-specific competences are included in the study:

1. *Intraorganizational* competence is the non-technical competence in an organization and includes knowledge about organizational culture, structure, informal networks, and other parts of the organization.
2. *Intraunit competence* concerns specific structural and cultural features of a particular organizational unit, and routines and workflow interdependencies within the unit.
3. *Firm-specific technical competence* is both firm and task specific, and applies to a small set of tasks within the company.

Employees' possession of each of these competences is expected to be associated with their accumulated exposure to the corresponding domains. This study investigates three kinds of exposure. Exposure may accumulate along the employees' intraorganizational career track, exposure may be governed by organizational structures, and exposure may occur through communication.

Previous research has primarily measured learning as performance improvements, has not been concerned with what is actually learned, and has measured exposure to information by proxies such as time or output volume only. In this study, I intend to contribute to the knowledge creation in this fragmented field by measuring different competence outcomes and by relating these competence outcomes to specified domains of information.

1.2 Background

Present research on the competitive advantage of firms, regions and nations is preoccupied with the significance of competence resources. Unlike visible (or tangible) assets such as money, technology and capital goods that can be purchased in the marketplace, basic invisible assets will to some extent be developed and maintained within the company. The more specific competences are, the more they will or must be produced by the organization itself.

Individuals may similarly be pursuing experiences and competences that are competitive in both the internal and the external labor market. This is, in other words, a question of how to manage ones career. From the perspective of the company the individual employee is the basic producer, storage facility and mediator of competence assets.

Recent theoretical developments it is argued that employee competences, rather than jobs, should be viewed as the basic building blocks of organizations (Lawler, 1994; Nordhaug, 1993). Rather than selecting people who fit particular job openings with specified competence requirements, the company should recruit those possessing more broadly defined competences including the ability to learn inside the company. The company should in particular, it is argued (Pfeffer, 1998), select on the basis of competences that are difficult or costly to change. Specific knowledge and technical skills are probably more easily acquired than general competences, such as communication, problem solving and ability to learn. This implies that organizations should select employees on the basis of general competences and let employees acquire more specific competences by designing an appropriate learning environment.

Despite the accelerating interest in these issues, there is a lack of concepts and empirical knowledge linking employee learning and competences to long-term company performance. There is a voluminous body of research on organizational learning curves, but virtually no systematic knowledge about the corresponding competence generation among individual employees. Traditional answers to questions about learning in the workplace have failed to specify what is actually learned by individual employees, there is little systematic knowledge linking learning conditions within the organization to specified competence outcomes.

This study is further motivated by organizational design issues in large divisionalized organizations. In multidivisional organizations, similar activities are performed in separate and often distant units. Learning may thus occur independently at different locations and mechanisms for sharing or transferring accumulated experience-based knowledge ("best practice") must be established before the company as a whole can profit from the learning (Chew, Bresnahan & Clark, 1990). When effective, such knowledge sharing is assumed to be one of the advantages of a large corporation. Some large (multinational) corporations acknowledge this problem and have implemented matrix-type (lateral) relations across divisional borders (cf. Jarmai, 1995).

Empirical evidence indicates that productive knowledge may reside for several years within a unit before being recognized and utilized by other organizational units (Aase, 1997; Szulanski, 1996). Similarly, research on diversification and multiunit companies have studied the *potential* for resource sharing rather than the *realized* synergies (Hansen, 1996). Limited empirical research exists to guide management and organizational design in this regard. This research consequently compares the effectiveness of such structural remedies to other vehicles of knowledge transfer, notably communication and personnel transfer across divisional borders.

1.3 Contribution

This study intends to contribute to knowledge about learning and competences among individuals in the workplace by:

1. Investigating empirically the competence outcomes of learning (as opposed to performance improvement outcomes)
2. Investigating learning effects on different types of domain-specific competences
3. Generalizing the notion of experience into a concept of learning through exposure to information
4. Developing empirical measures of different types of domain-specific competences

1. Learning outcomes and level of analysis

Previous research on learning in organizations has focused on the increase in productivity with time or cumulative output ("learning curves"; Yelle, 1979) and effects of experience on work performance (McDaniel et al., 1988). Learning curve studies in industrial settings have to a large extent measured performance improvements for larger units, such as plants, organizations (Argote, 1996), or industries (Sheshinski, 1967). Learning is defined as a change of *capacity* to perform and the distinction between learning and performance is considered to be crucial. Research on learning in organizations has largely ignored what competences are actually acquired by individuals.

This study adresses three conceptual and one methodological shortcoming of previous research on learning. First, learning may produce competences that can be applied to other than the current tasks, such that the employee's capacity to perform may not be fully revealed through the employee's current tasks. Second, job performance is the combined result of various aspects of performance, such as technical performance, planning and coordination between jobs. If different competence components are related to each aspect of performance, learning as measured by performance improvements does not identify within which competence component learning has taken place. Third, although performance improvement curves are robust indicators of learning, performance in a particular job is also affected by other factors than competence,

notably motivation, role constraints and routines, implying that the employee's actual capacity to perform may not be revealed. Finally, because objective performance measures such as output per time unit or percentage of errors may not be available at the individual level or such measures may not be comparable across observations, performance improvements may not be used as an indicator of learning.

This study intends to contribute to research on learning in organizational settings by investigating the *actual* competence acquired by individuals in the workplace, rather than by investigating work performance outcomes as indicators of competence changes.Table 1.1 summarizes previous research by level of analysis and outcome variable studied (Table 1.1 is discussed in greater detail in Chapter 2). Due to the large number of studies and reviews on performance outcomes of learning, only sample references are reproduced in the left column.

Table 1.1: Learning outcome and level of analysis

	Learning outcome studied	
Level of analysis	**Performance (productivity)**	**Competence**
Individual employee	Individual learning curves (Thurstone, 1919; Yelle, 1979); job experience effect on job performance (McDaniel et al., 1988); effects of experience and training on different types of performance (Motowidlo & Scotter, 1994); experience, performance and earnings (Medoff & Abraham, 1980)	Tenure and job rotation effect on different types of competence (Campion et al., 1994); technical and non-technical competences (Arnold & Davey, 1992); job experience effect on job knowledge (Schmidt, Hunter & Outerbridge, 1986; Morrison & Brantner, 1992); experience effect on knowledge in specific professional field (Tubbs, 1992)
Organization	Organizational learning curves (Yelle, 1979); progress functions (Dutton, Thomas & Butler, 1984)	Resource based theory of the firm (Kogut & Zander, 1993; Prahalad & Hamel, 1990; Markides & Williamson, 1996); organizational aggregates of individual training (Nordhaug, 1991)

2. Different types of competence outcomes

Although learning has been defined as a change of capacity to perform, previous research has been concerned with learning measured in terms of actual, *overall*

performance. Job performance is the combined result of various aspects or domains of performance, for example technical performance, planning and coordination. Learning may occur independently in different domains. Previous research on performance improvements has generally failed to investigate what is actually learned in different domains. The small amount of previous research on different competence outcomes is fragmented, has relied on ad hoc conceptualizations and has not been guided by a general theoretical framework.

In this study, I accordingly decompose learning outcomes into domain-specific competences (Nordhaug, 1993) and investigate the degree to which different competences are differently affected by different learning conditions. In particular, I draw a distinction between technical and non-technical firm-specific competences.

3. Learning and the notion of experience

Despite indisputable empirical success, learning curve studies have proceeded without a clear theoretical understanding of the concept of experience (as measured by time or volume). At the organizational level, little empirical knowledge about the intervening mechanisms exists. At the individual level, little is known about the *content of experience* measured in terms of time or volume. I consider time and volume merely as proxies of the amount of work-related information the individual has been exposed to. Experience is frequently used in a common-sense fashion incorporating the *conditions or events* giving rise to learning as well as *that which is learned.* This notion of experience does not distinguish properly between the causes and the consequences of learning. Due to the conceptual imprecision and connotations of "experience", I will avoid this term.

Accordingly, I generalize the notion of experience into a concept of learning through exposure to information. This study is based on the notion that learning is a function of exposure to work-related information. Information is in turn defined as concrete sense data or perceptions.

4. Measurement

The distinction between multiple dimensions of work performance has recently generated a number of empirical studies (e.g., Motowidlo & Scotter, 1994). However, only a small number of attempts to operationalize and measure multiple types or dimensions of work-related learning outcomes have been published (Campion et al., 1994; Arnold & Davey, 1992). These efforts have however not been guided by a conceptual framework. In this study, I develop and apply self-report measures of multiple competences as defined by Nordhaug (1993), notably technical and non-technical firm-specific competences.

1.4 Overview of thesis

This thesis is organized as follows. Chapter 2 contains a review of relevant literature and discusses and defines the outcome variables studied. The second part of the chapter specifies exposure in terms of three sets of variables and discusses their expected impact on competence outcomes. The final part of the chapter then summarizes these discussions in a set of specific hypotheses.

In chapter 3, the research designed to test these hypotheses is described. This includes the empirical setting, data collection method and sampling of respondents. Measurement of variables and descriptive results are presented in chapter 4.

Chapter 5 reports results of hypothesis testing. This includes tests of linearity, tests of effects and tests of differential effects. Results are discussed in chapter 6, and conclusions and implications are outlined.

2. THEORY AND PREVIOUS RESEARCH

Research on learning in organizations has generally focused either on increases in productivity for a specified piece of work at different organizational levels, or on the individual learning related to performing a specific job. This research has generally failed to specify the content of what is actually learned. Competence is often equated with education and experience without specification of what the employee actually knows or is skilled at. More recently, separate dimensions of competence and performance have been proposed and identified, notably general, task specific and firm specific competence. In this chapter, I will first identify and discuss competence outcomes along these dimensions. Outcome variables in the present study will be defined accordingly.

Learning is usually assumed to result from training, instruction, experience, imitation, and advice. The present study emphasizes *learning that results from the kind and amount of information to which the individual is exposed.* More precisely, I expect that exposure to a specific work-related domain will increase competence related to that domain. The second section below will discuss this general proposition in detail and identify a set of variables that, as special cases of the general mechanism, are expected to affect the outcome variables. Given the above conceptualization of work-related competences, this chapter will focus on exposure mechanisms that contribute to development of such competences in the workplace.

2.1 Individual work-related competences

The present study focuses on work-related competences, that is, competences which contribute to performance in the workplace. Competence is viewed as the *combination* of knowledge and skills. Knowledge is in turn defined as the individual's possession of specific information about matters and information about how matters are related. Skill is the special ability to perform work-related tasks. Knowledge and skill are closely connected at least in the sense that some knowledge, whether explicit or not, about matters and their relations is necessary to perform tasks (Nordhaug, 1993). Competent

performance is characterized by increased smoothness and automaticity of performance, decreased need for mental effort, and increased stability of performance under stress. Competent performance requires that knowledge is actually translated into skills. The extent of knowledge versus skill components involved in a specific task performance does however depend on the characteristics of the task. A number of basic tasks, such as walking or biking, requires some knowledge but extensive (motor) skills. The same verbal skills for instance, may be used across a wide range of knowledge domains.

Competence is the *capacity to perform*, and should not be equated with education and experience (which are merely sources of competence) nor should it be equated with performance of current tasks (performance is an indirect measure of competence with regard to those specific tasks). Performance may be poor for many reasons other than lack of competence.

"Learning" has frequently referred to a process as well as the outcome of that process. Thus, "learning" has captured what is defined as "competence" in the present study. To avoid further semantic confusion, I define learning as the process through which competence is acquired. See part 2.2.1 for details.

Transferability of competences

Learning theorists have been concerned with the degree to which learning related to one task can be transferred to a different task. It is widely assumed that, for example, knowledge gained in the classroom can later be applied in a different setting, such as the workplace. This is the question whether or to what degree competence acquired in one context or with one task can be used in a different context or in the performance of a different task (Busch, 1993).

Transfer occurs when competence related to one task reduces the need for learning related to a different task, i.e., when there are spill-overs between different areas of competence. Being able to ride a bike, for example, makes it easier to learn to drive a motorcycle. If one already knows how to ride a *red* bike, no additional learning is needed to ride a *blue* bike. Learning a second foreign language is assumed to be easier than learning ones first foreign language. Basic education (i.e., non-vocational) and

formal disciplines such as logic and computer programming are based on the premise that competences thus acquired can be transferred to a broad range of domains. Research on training has in particular been concerned with the degree to which competences acquired in a training program are transferred to an actual job. Theorists have also suggested that learning within one domain may, in some cases, reduce the capacity to learn in another domain. Negative transfer, or interference, occurs when competence in one domain inhibits learning in a different domain. Experimental studies indicate that interference, although rare, can occur under very specific circumstances (Pennington & Rehder, 1995).

The existence of positive transfer suggests that there are non-specific competence components that can be applied to broader sets of activities. A large proportion of driving skills for example may be common to all vehicles, even if additional skills are needed to drive a motorcycle compared to driving a car. *Learning one activity may thus be assumed to produce both competences specific to that activity and competences that can be applied to a number of other activities.*

This suggests that an individual's competence can be decomposed into specific and less specific components, an assumption that apparently departs from both early and more recent theories of learning suggesting that transfer requires elements of the learning situation and the application to be identical or at least common (Bower & Hilgard, 1981). A slightly revised version of the common-elements assumption would be that learning *simultanously contributes to a number of different competences that vary in their type and degree of transferability.*

One single instance of learning may thus produce or modify several competence components. Each component can be characterized by the domains to which it can be applied. Motorcycle maintenance, for example, may produce very specific knowledge about compact, internal combustion engines as well as general problem solving skills. Diagnostic strategies are in fact surprisingly similar across fields such as medicine and mechanics, whereas specific knowledge needed to apply problem solving strategies differ. To some extent, intelligence (as measured by IQ tests) can be viewed as a measure of the individual's capacity to generalize (to build general competences) from

specific experiences, and to use this general competence in novel situations. Limited empirical research on this issue exists (see Pennington & Rehder, 1995, for a laboratory experiment).

Competence types and domains

Similar to the notion of transferability, some research in applied settings has been concerned with the characteristics of competence domains.

Research on expertise and development of expert systems has demonstrated that competence may be highly domain specific and that expert performance requires extensive and complex domain specific competence (Ericsson & Lehman, 1996). The first expert systems were constructed by combining a single set of very general inference rules with massive amounts of domain-specific knowledge to produce decisions in areas such as medical diagnosis. Later systems modified this by incorporating a number of general inference rules tailored to different types of generic tasks such as monitoring, design and diagnosis. In addition, expert performance in a specific domain also involves general problem-solving and learning strategies that apply across a broad range of domains (Pennington & Rehder, 1995). Troubleshooting (diagnostic) strategies, for example, apply to very different fields such as medicine, electronics, mechanics, consulting and computer programming. This research identifies a number of concrete tasks or domains (notably chess, medicine and computer programming) where expert performance is readily observed, but does not suggest any classification of competence applicable to work organizations.

Similarly, Ohlsson (1996) proposes that performance improves when actions based on general knowledge causes errors that are corrected by specializing faulty knowledge structures. In other words, domain-specific knowledge is created when a "section" of the individual's knowledge is modified on the basis of domain-specific information (for example feedback). It is further assumed that the domain-specific knowledge is activated only in the appropriate domains. (This implies that some sort of meta-knowledge that differentiates among domains and retrieves the appropriate domain-specific knowledge, must also be present.) Although Ohlsson's model may not

accurately reflect the physiological process of learning and organization of knowledge, it does suggest how an analytical classification of general and domain-specific knowledge may be constructed. Similar results were obtained in experimental research in consumer behavior, where the effects on decision making of domain-specific knowledge and general knowledge about decision strategies were investigated (Coupey & Narayanan, 1996).

The discussion above clearly indicates that it is frequently assumed, implicitly or explicitly, that a person's competence is a divisible entity. A person may thus possess separate *competences* or competence *components* that can be classified or characterized. I assume that it is possible and that it makes sense to decompose competences, although it may not be clear if basic, indivisible competence components exist. Research may never arrive at a definite answer about what constitutes a single and indivisible competence. Although it has been demonstrated that training and enriched experience induces measurable neurochemical and anatomical changes in the brain (Rosenzweig, 1996), I suspect that attempts to solve this issue by reducing competences to their neurological constituents will be far from successful. It seems clear that competences can possibly be decomposed into an unmanageable number of components.

What we need is a classification procedure that produces a manageable number of competence types while differentiating among competences in a theoretically or practically relevant way. Again, there is no right or wrong classification. Alternative classifications should rather be viewed as more or less appropriate with regard to specific purposes. The appropriateness of a competence typology might be assessed by the degree to which the typology differentiates among outcomes, that is, the degree to which different competence types are related to different outcomes. In the context of a work organization, different competences should produce different behavioral and performance outcomes, which in turn should be related to career outcomes and organizational performance. In particular, performance should be an outcome of the interaction between job content and employee competences.

The appropriateness of a classification can also be assessed by the degree to which different competence types share a set of antecedents. It might be that different

individuals tend to acquire different competences even if they are assigned similar tasks or exposed to the same environment. It might also be that different environments give rise to different competence types. It might also be that different antecedent conditions gives rise to different competences through entirely different causal processes. In short, the value added of such a classification depends on its ability to differentiate among unique causal paths or processes relating antecedent conditions (individual dispositions, environment) to competences, and to behavioral and performance outcomes (Motowidlo et al., 1997).

Competence types in work organizations

However crucial the issues of transferability and competence domains, we are still short of an accepted conceptual framework with regard to competences in work organizations. Previous research has made some attempts to identify a typology of competences or a typology of behavior relevant to any work organization.

Leadership is one specific area where this issue has been studied. Research in the area of leadership has been concerned with competence types relevant to managerial work. The most widely accepted taxonomy of managerial competences distinguishes among technical, interpersonal and conceptual competences (Yukl, 1998). A technical competence includes knowledge of procedures and techniques for conducting an activity and the ability to use equipment relevant to that activity. Interpersonal competences for example the ability to understand other persons, ability to communicate and to establish effective relationships. Finally, conceptual competence is general analytical ability (reasoning, perception, conceptualization and problem solving). A political dimension has been added to account for the individual's ability to develop and exploit power bases (Pavett & Lau, 1983). Based on qualitative data, Kotter (1982) concluded that well-performing general managers were particularly knowledgeable about the business and the organization they were in. These managers had extensive knowledge about specific products, competitors, markets, customers, technologies, unions, government regulations, different people in the organization and in the business, organizational procedures and company history.

Similar typologies have been developed in other research traditions. Sonntag and Schäfer-Rauser (1993) identified three components of individual competences in the workplace: social (interpersonal), methodical (conceptual) and technical competences. Campion et al. (1994) applied factor analysis to data on competence outcomes and identified three dimensions: administrative (including interpersonal and conceptual skills), technical and business competence. The technical – social distinction closely corresponds to interpersonal skills versus specialist competence (Arnold & Davey, 1992). A study of continuing education and knowledge updating among engineers (Kozlowski & Farr, 1988) distinguished among competence maintenance activities, technical competence and administrative skills by means of factor analysis. In a recent conceptual paper, Matusik & Hill (1998) distinguished between private knowledge (knowledge unique to the firm) and public knowledge (knowledge residing in the public domain) as well as between component and architectural knowledge. Component knowledge is knowledge that relates to discrete aspects or components of an organization's operations. Architectural knowledge relates to the organization-wide routines for coordinating the various parts of the organization.

Recently, typologies of work-related behavior and performance have emerged, notably task performance vs. contextual performance (Motowidlo & Scotter, 1994; Murphy & Shiarella, 1997), technical and extra-technical proficiency (Borman et al., 1997), and in-role versus extra-role behavior (Dyne & LePine, 1998). This stream of research has focused on the effects of extra-role behavior on group and organizational performance, and on the ability of personality characteristics (such as intelligence and conscientiousness) to predict different types of behavior and performance (Hattrup et al., 1998). Campbell et al. (1990) distinguished between job-specific and organization-wide performance measures. In a later paper, Campbell (1994) listed as much as eight basic components of work performance, including job-specific proficiency, non-job-specific proficiency, communication proficiency, facilitating co-working as well as supervision and management. Arvey and Murphy (1998) concluded that the most exciting area of research in this field is the development and elaboration of the notion of contextual performance. Accordingly, an appropriate conceptualization of the competence determinants of such performance is also needed. Motowidlo et al. (1997) acknowledge

that task and contextual performance are affected by different competences but do not suggest a framework for analysis beyond the task related – contextual distinction.

Traditionally, research has been most concerned with the degree to which competence is tailor-made to work in a particular organization or not, and how this may affect employee and employer behavior (e.g., Davis-Blake & Uzzi, 1993; Kalleberg & Reve, 1993). Research in this tradition has thus produced empirical knowledge about the effects of firm specific competences. Working from a different research agenda, Arnold & Davey (1992) identified five competence subscales: company know-how, interpersonal skills, knowledge of company products/services, specialist competence and the use of competences to achieve results. Company know-how and knowledge of company products/services clearly capture aspects of firm-specific competence.

The discussion above can be summarized in two points: 1) competence, behavior and performance are multidimensional and 2) relevant dimensions of competence include technical (task), analytical (methodical/conceptual), political, business issues, social/interpersonal, and firm specific.[1]

A two-dimensional typology

Previous research on different types of competences is fragmented, has been based on ad hoc conceptualizations of work-related competences and has not been guided by a general and coherent theoretical framework. In the context of an organization, most of the dimensions and competence types identified in the research reviewed above can be incorporated into a single framework by distinguishing individual competence along analytically independent dimensions. Nordhaug (1993) elaborated a typology on the basis of competences' degree of task, firm and industry specificity.

First, there is the degree to which the individual employee's competence is targeted at a set of particular tasks. This is the degree of competence *task specificity* (cf. Gordon & Fitzgibbons, 1982; Yukl, 1998). Task specificity corresponds to the task – contextual and the technical – extra-technical distinctions as well as in-role versus extra-role

[1] Contextual performance is related to both social/interpersonal and non-technical firm specific competences.

behavior. Task specificity captures the distinction between technical and administrative skills (Campion et al, 1994) and the distinction between social and methodical competence on the one hand and technical competence on the other (Sonntag & Schäfer-Rauser, 1993), as well as the distinction between component and architectural knowledge (Matusik & Hill, 1998).

Second, there is the degree to which competence is specialized for work in a particular *context*. I distinguish among four levels of context specificity: industry, firm and organizational unit as well as non-specific. Competence can thus be characterized by *firm specificity* and *industry specificity*, as well as *unit specificity* in large and differentiated organization. Firm specificity implies industry specificity and unit specificity implies firm specificity. Similarly, industry specificity implies an intermediate level of firm specificity because industry specific competences are relevant to a limited set of firms only. This is a further refinement of the traditional distinction between general and firm specific training (e.g., Davis-Blake & Uzzi, 1993; Kalleberg & Reve, 1993). The terms private and public knowledge have also been used (Matusik & Hill, 1998). Company know-how and knowledge of company products/services are special cases of firm specificity (Arnold & Davey, 1992).

These dimensions incorporate both *type* and *degree* of competence idiosyncrasies, that is, a competence component is characterized by a high or low degree of specificity with regard to different types of domains. It must be assumed that transfer of competences across situations requires the situations to have similar elements. The difficulty lies in specifying what the crucial similarities are and at what level of generality the mediating elements are found. This typology continues the debate on transferability of learned competences by explicitly specifying type and degree of transferability (Pennington & Rehder, 1995).

Considering only high and low cases for each of the two dimensions gives a total of eight main types, see Figure 2.1. Each cell in Figure 2.1 indicates competence of a different form and degree of specificity. *This classification defines the outcome variables of the present study.*

Task specificity	low Unit specificity high			
	low Firm specificity high			
	low Industry specificity high			
low	*1. General Competences*	*2. Industry Competences*	*3. Intraorgan. Competences*	*4. Intraunit Competences*
high	*5. Standard technical competences*	*6. Technical trade competences*	*7. Firm specific technical competences*	*8. Unit specific technical competences*

Figure 2.1: Competence typology (adapted from Nordhaug, 1993:58)

General competences

In the upper left cell are general competences that can be useful across tasks and work environments. This category includes analytical skills, creativity, capacity for being systematic, knowledge and mastery of foreign languages, cooperative skills, communication skills, self-management skills, career management knowledge and skills, and ability to learn. Anecdotal evidence suggest that it may in many respects be the largest and most influential type of competence (cf. Løwendahl & Nordhaug, 1994). The US Department of Education (1996) argues that the school-to-work program should help students acquire general workplace and labor-market competences such as teamwork, problem solving, career management, critical thinking, communication and interpersonal skills as well as other highly transferable skills that can serve students no matter what career they choose. Although the capacity for learning is largely inherited or developed during the first years of life, learning-to-learn may also occur. General competence includes more fine-grained classifications such as interpersonal and conceptual competence (Yukl, 1998) and social and methodical competence (Sonntag & Schäfer-Rauser, 1993), as well as broader categories such as administrative competences in which Campion et al. (1994) included planning, organizing, communication, interpersonal, leadership, self-improvement and cognitive skills.

It should be emphasized that general competences, although not tailored to specific tasks, are not irrelevant for the accomplishment of concrete tasks in a concrete work environment. Communication and cooperative skills may be crucial when tasks involve

contact with co-workers, customers or supervisors. A number of general competences may be needed to solve unusual problems and to master emerging and future tasks. General competences may thus contribute substantially to both productivity and quality as well as flexibility and ability to change. These competences are particularly important in the sense that their value is left virtually unchanged even if circumstances change. Despite the importance of general competences, no specific educational program is designed primarily for competences such as analytical skills, creativity and communication.

Industry competences

Industry competences can be useful for a range of tasks within a particular industry. Knowledge about industry structure, competitors, key actors, networks and alliances in the same industry and related industries are examples of industry competence. Campion et al. (1994) captured elements of industry competences under the heading business knowledge, including for example knowledge of general business issues and knowledge of the external environment. Similarly, Arnold and Davey (1992) included elements of knowledge about competitors in the category knowledge about company products/services. Such competences are important for managers and staff who make strategic decisions, but also for personnel at the customer and supplier interface. The US Department of Education (1996) argues that students in a high quality school-to-work program should learn all aspects of an industry, including labor, health and safety, management and finance. Generally, no educational programs are designed specifically for this type of competences, many students do however acquire substantial industry knowledge during the final stage of their training, for example by working in apprenticeships or by completing case studies. Most of this knowledge is however acquired informally in various arenas.

Intraorganizational and intraunit competences

The third category, intraorganizational competence, is the internal general competence in an organization and covers knowledge about colleagues, organizational culture, structure and strategy, informal networks and coalitions. Knowledge about various

organizational units, their activities and how their activities are connected may also prove important. In the last cell in the upper row, we find the corresponding intraunit competences. This category covers specific structural and cultural features of the unit, routines, and interdependencies of workflows inside the unit. Company know-how and knowledge of company products/services (Arnold & Davey, 1992) are special cases of intraorganizational and intraunit competences.

These competences must generally be acquired within a particular organization. Most employers offer newcomers at least a few hours or days of introduction to the organization. However, in large organizations the time and effort needed to learn about people, culture and activities will usually be substantial, several years may be needed. Even for medium-sized units within an organization, employees may need years of learning to achieve desirable performance.

Knowing *who* ("know who") is able to solve a particular problem may be as effective as being able to solve the problem oneself (cf. Ibarra, 1992). Full utilization of an organization's accumulated competences requires widespread knowledge about the content of these competences and knowledge about where these competences reside in the organization (O'Dell & Grayson, 1998). This is particularly important in large organizations where similar activities are duplicated across a number of dispersed sites. Szulanski's findings (1996) indicate that ignorance (with regard to sources of knowledge) is the biggest barrier (particularly in large organizations) to knowledge utilization across intraorganizational borders. Nahapiet and Ghoshal (1998) argue that organizations have an advantage over markets in creating and sharing knowledge, intraorganizational competence among employees plays a key role in this respect.

This suggest that intraorganizational competence captures some aspects of what is referred to as social capital (Coleman, 1988). Norms and sources of information cannot be resources for action unless the individual possesses adequate knowledge about these social structures. We could thus make a refined distinction between human capital issues, such as knowledge about co-workers' competences, knowledge about norms of helping behavior and knowledge about specific co-workers' willingness to help, on the one hand, and social capital issues, such as the existence of norms, networks,

interpersonal relations and exchange obligations, on the other hand. According to the present framework the distinction between social capital and human capital may be more subtle than originally proposed by Coleman. There may in addition be substantial interactions between competences and social capital, for example between employees' know-who and organizational norms about helping behavior.

Standard technical and technical trade competences

Along the second axis, task specificity, there is what we may call standard technical competence. Such competences apply to work processes that are not specific to any firm or any industry, for example accounting and typing. Technical trade competence covers work processes that are specific to one industry, for example hairdressing, newspaper journalism and bartending skills. These types involve knowledge about methods, processes and techniques for conducting a specialized activity and the skills to use tools and operate equipment related to that activity. Standard technical competences are relevant to tasks across firms and industries, whereas technical trade competences are confined to one industry. For a large number of vocations standardized educational programs are available. In Norway, for example, most of the programs are offered by public schools. In addition, there are apprenticeships (or similar jobs) and extensive on the job learning. A number of these competences are distinctive for professions or jobs that require a public license, physicians, chauffeurs and electricians for instance.

Firm- and unit-specific technical competences

Firm-specific technical competences are both firm and task specific; they apply to a small set of tasks within a particular company. Unit specific technical competences include competences that apply to a small set of tasks within a specific organizational unit only. Although not identifying them as firm-specific competences, Campion et al. (1994) classified elements of firm-specific technical competences, for example knowledge of procedures and practices, into the broader category of technical competences. Similarly, Arnold and Davey (1992) captured both specific and general technical competences in their measure of specialist competence. However, virtually no attempts have been made to distinguish firm- or unit-specific competences from the

more general technical competences and from intraorganizational and intraunit competences.

No standardized educational program can be expected to exist for competences that are relevant to a small number of jobs in one specific company. In a large number of companies the number of similar jobs is too small to justify an internal educational program. Firm- and unit-specific competences must generally be acquired or developed within that particular organization. These are thus the least transferable competences.

In some jobs the extent of firm and unit specific technical competences may be surprisingly large. Plants, computer systems and buildings are often tailor made; use and maintenance consequently demands some specific competences. Products and services are quite often unique for that company; production and marketing of these products and services accordingly requires specific competences. Companies or company units operate in a specific place where knowledge about specific operating conditions (including routines and technology adapted to those conditions) is essential. A taxi driver for instance needs both car driving skills (standard technical competence) and knowledge about streets and addresses in the particular town he or she is working. In the petroleum industry, every field is different with regard to size, depth and content of the reservoir. Moreover, operating conditions such as climate, land surface, sea depth and distance to shore are essential. In some jobs several years are needed to learn the job properly. Whatever the time and effort needed to acquire these competences, they are crucial for productivity and quality.

Variable definition and characteristics of individuals

It should not be assumed that an *individual* can be classified according to this typology. One individual can, however, possess competences in all categories, so that competences possessed by the individual can be classified. Competences are then the relevant level of analysis in this framework. At the individual level of analysis it may be more suitable to consider each category as a variable in its own right. If each category in the typology is treated as a variable, then these variables together characterize the

individual and not particular competences within the individual. *In the present study, each category defines a variable.*

Person A may for example have extensive intraorganizational as well as trade technical competence, whereas person B may have extensive trade technical competence, firm specific technical competence and general competence. The human capital of A and B are not adequately described by degree of competence specificity nor by their possession of any particular type of competence. The existence of a high level of one type of competence inside the individual, does not necessarily exclude the existence of high levels of other types. Both the amount or level of each type of competence and the combination of these into a competence mix or profile characterizes the individual employee. (An employee's mix of competences determines what type of job she or he is most suited for and indicates what competences should be developed before the employee enters a particular job.)

Relations among competence variables

Although different competences are regarded as separate variables, covariations among the various types of competences may affect the individual competence profiles. Covariations may be positive as well as negative and may arise through several mechanisms.

First, there may be *negative* relations among different types of competences. Although there are no known limits to how much knowledge an individual can potentially acquire, individuals have limited learning capacity for a given period of time. Different competences will clearly compete for the individual's limited time to learn. To the extent that competences degenerate if left unused (cf. Argote et al., 1990; Arthur et al., 1998), different competences may also compete for the individual's scarce capacity to maintain them. It is also possible that possession of one competence may halt the acquisition of a different competence, a phenomenon known as negative transfer or interference. Empirical findings indicate that interference, although rare, can occur under specific circumstances (Pennington & Rehder, 1995).

Second, there may be *positive* relations among competences (see paragraph on transferability above). General technical competences may thus increase the speed and capacity for acquiring firm-specific technical competences *in the same technical domain*. More general knowledge, for example in terms of a professional education, may then serve as foundation for the acquisition of more domain-specific competence (domains related to the professional field). It is also possible that the individual, based on specific competences, is able to form general competences that in turn facilitate new learning in specific domains. These issues are commonly, although somewhat imprecisely, referred to as transfer of learning (Bower & Hilgard, 1981; Pennington & Rehder, 1995; Baldwin & Ford, 1988). In addition, general competences such as analytical skills and creativity probably affects learning in any domain, whereas social competence probably speeds up learning in specific social domains (e.g., particular co-workers, organizational culture).

The present typology of competences offers a more precise framework of transfer mechanisms. Rather than focusing on the degree to which learning transfers from one situation (notably the training situation) to another situation (the job), this framework suggest that one situation may give rise to several different competences that can be applied to several different domains and specifies transfer as the competences' type and degree of specificity. Learning in the workplace can for example create firm-specific technical competences and intraorganizational competences. Firm-specific competences can be applied to jobs within the same technical field in the company, whereas intraorganizational competences are relevant to all jobs in the company.

Level of analysis

Firm specificity has been used as a job-level or firm-level variable and measured as the amount of within-firm training and experience *required* for a particular job or for any job in the firm (Baron et al., 1986; Pfeffer & Cohen, 1984). Others have been less clear about the appropriate level of analysis of competence firm-specificity (Althauser, 1989). Even if conceptualized at the job level, firm specificity is typically measured at the employee level as the amount of firm-specific training received by the job-incumbent after hiring.

The present study focuses instead on the individual level of analysis (cf. Spenner, 1990). Even if variables at the individual and job level appear to be similar, the purpose of research, theory and measurement strategy are fundamentally different. I am studying the *actual* competences of individual employees not the competence *requirements* of particular jobs. Amount of relation-specific human capital has typically been studied as a determinant of employment relations. In this study, I am concerned with determinants of actual firm-specific competences among employees, not with the causes or consequences of competence requirements or amount of relation-specific human capital.

Explaining job-level or firm-level competence requirements is not the same as explaining individual competences. The processes through which firm-specific competence requirements arise are not related to the processes through which individuals acquire competences. Similarly, the consequences of competence requirements are mostly different from the consequences of individual competences. However, the *interaction* between actual competences and competence requirements probably affects a number of relevant outcomes such as satisfaction and performance.

It should finally be noted that this approach to the study of competences departs from research traditions distinguishing only between skilled and unskilled work (Spenner, 1990). These traditions measured competence simply by grouping jobs into professional, managerial, and blue-collar, and by assuming that these groupings indicate the skill required by jobs and skills possessed by the employee. Such occupational groupings indicate the type and extent of professional training required to be admitted into a profession or occupation, and may correlate with the extent of learning required to do a job. Occupational groupings as such do not provide precise measures of actual competences nor do they indicate the learning occurring in the workplace. A related approach uses wages or years of education as indicators of skill level for individuals or occupational groups. Wages are, however, heavily influenced by other factors such as trade unions, public regulations, supply/demand and specificity of competences. Years of education mainly captures standardized competences and does not take into account informal, life-long learning.

Summary and scope of study

This is a study of competence acquisition in the workplace. Employees generally acquire standard technical and technical trade competences through vocational or professional education. These competences can also be developed through work experience in a range of different industries or organizations. Industry competences can also be acquired through professional education as well as through experience in different firms.

Firm specific competences (including unit specific), however, can generally be acquired within that organization only. These competences should thus to a large extent be the outcome of learning at work. In other words, these competences are relevant indicators of learning processes occuring within the organization. This implies that the acquisition of firm specific competences is not confounded by competence acquisition taking place in a different context. In a cross-sectional study, this facilitates the establishment of temporal order among variables. Variations in the level of firm specific competences can then be attributed to variations in the conditions or events taking place *after* the employee joined the organization. Firm specific competences are thus appropriate measures of informal learning. Despite the importance of firm specific competences to company performance and employee intraorganizational career, only limited and fragmented empirical research exists about how such competences are acquired. *I accordingly limit this study to the firm-specific end of the competence typology.*

One important purpose of this study is to investigate if different antecedent conditions affect different competences differently, that is, if each competence type has a unique set of determinants. To investigate this issue, I had to include at least two competence types. Assuming that determinants would differ along both dimensions (firm/unit and task specificity) in the typology, I decided to contrast competences that differ along both dimensions. In order to vary only one dimension at the time, I used intraorganizational competence as a point of departure and then chose intraunit competence as a contrast along the firm/unit specificity dimension and firm specific technical competence along the task specificity dimension. This research will thus be limited to *intraorganizational, intraunit and firm specific technical competence.*

Task specificity	low Unit specificity high			
	low Firm specificity high			
	Low Industry specificity high			
low	*1. General Competences*	*2. Industry Competences*	*3. Intraorganizat. Competences*	*4. Intraunit Competences*
high	*5. Standard technical competences*	*6. Technical trade competences*	*7. Firm specific technical competences*	*8. Unit specific technical competences*

Figure 2.2: Competences included in study

To summarize, outcome variables in this study are characterized as follows

- competence is the capacity to perform through the combination of knowledge and skills
- competence is related to but not the same as education, experience or current performance
- a person's portfolio of competences can be characterized by each component's type and degree of domain specificity
- outcomes include three separate firm-specific competences
  - **A.** *intraorganizational* competences are the non-technical competences related to one particular organization and include knowledge about colleagues, culture, structure, procedures, networks and activities in different parts of the organization.
  - **B.** *intraunit* competences are the non-technical competences related to one particular organizational unit and include knowledge about colleagues, culture, structure, routines, tasks, work-flows and work-flow interdependencies within the unit
  - **C.** *firm specific technical* competences are task-specific competences related to one particular organization and include skills needed to complete specific tasks in the firm, competences needed to operate or maintain tailor-made equipment, knowledge about firm-specific work-practices and competences related to manufacturing unique products
- these competences are characteristics of individual employees (not of jobs or firms)

2.2 Learning in organizations: Theory and research

Competences are acquired through learning. This chapter provides an outline of learning theory (2.2.1) and discusses the notion of experience in relation to learning in organizations (2.2.2). The central assumption that learning results from the kind and amount of information to which the individual is exposed, is discussed in both sections.

2.2.1 INDIVIDUAL LEARNING

Learning is one of the basic mechanisms through which individuals adapt to, relate to and control the environment. Learning, knowledge and skill have thus been major topics, or possibly *the* major topics, in psychology (Bower & Hilgard, 1981; Melton, 1950). The cognitive and epistemological issues were inherited from and are still partly shared with philosophy: How do we come to know anything about the external world? What is knowledge? What are the limits of knowledge?

Among the classical philosophers, for instance, Plato argued that knowledge was inherited whereas Aristotle argued that knowledge derived from sensory experiences and was not inherited. For Plato, concrete experiences triggered the search for or awareness of innate knowledge, whereas for Aristotle only the capacity to abstract knowledge from specific experiences was innate. These issues identified by early philosophers are still relevant to the study of learning and knowledge. Theories, metaphors and empirical findings from psychology, notably cognitive psychology, have in turn informed the philosophy of knowledge and science.

This section discusses the concept of learning, characteristics of research on individual learning and finally discusses the process of individual learning in general and outlines the conditions that must be present for learning to take place.

A. The notion of learning

Learning is a change in the individual's knowledge and skills. Whereas *knowledge and skill* refers to the individual's content of mind, state of knowing or capacity to perform, *learning* refers to the process through which these characteristics of the individual are changed. *Learning* is hence viewed as *acquisition of competence*. This definition allows learning to occur without an (immediate) change in the individual's current behavior – a common ingredient in traditional definitions of learning (cf. Bower & Hilgard, 1981). This section will discuss the concept and phenomenon of learning, and contrast learning with other mechanisms of change. In particular, I will focus on the following crucial issues in the study of learning:

- learning as a change in actual versus potential performance
- the role of feedback and reinforcement
- learning as a permanent and stable change
- learning versus growth and maturation

Changes in actual versus potential performance

Learning refers to a change in the individual's *capacity or potential* to perform, and not necessarily an actual or immediate change in behavior (cf. Hergenhahn & Olson, 1993). Individuals may learn but may not have the opportunity to perform or demonstrate enhanced competence. Knowledge may be stored in memory for months or years until called for. Skills be may acquired in one setting and demonstrated later in a different setting. In laboratory conditions where experiments are specifically designed to measure changes in performance as learning proceeds, this is not crucial. In organizational settings, a number of constraints on behavior may not allow the individual to execute tasks at their maximum capacity. Task execution may, for example, be controlled by machines or organizational routines, or jobs may not be sufficiently challenging for the employees to demonstrate their true competence level. In addition, learning may produce competences that can be applied to other tasks than the current ones (Pennington & Rehder, 1995), such that the full potential will not be revealed with the current tasks. Finally, the individual may not be motivated for maximum effort, because we can reasonably assume that actual competence interacts with constraints and motivation to produce actual performance.

Feedback and reinforcement

Traditional definitions of learning often require that learning occurs as result of feedback or reinforcement (Elster, 1989; Melton, 1950). By introducing reinforcement in the *definition* of learning rather than as a *cause* of learning, such definitions are inappropriately restrictive and capture only one source of learning – information about the results of one's own behavior. Other sources of information, co-workers or mentors for instance, may be equally or more important. In addition, feedback models confound the informational and motivational effects of feedback. These models do not distinguish properly between the individual's knowledge about means-ends relations and the individual's motivation to choose the behavior that produces a certain outcome. In this study, I am not restricting the learning concept to the changes occurring after feedback or reinforcement.

Permanent and temporary effects

As stated above, changes in the capacity to perform should be relatively *stable* and relatively *permanent* (persist for a substantial period of time). Learning should thus be clearly distinguished from a number of transitory states. For highly repetitive tasks, some loss of speed and accuracy of performance may be observed during long periods of work, whereas performance improves after a break or a change of task. This is a matter of fatigue (or boredom) and recovery and should not be attributed to learning mechanisms. Hunger and thirst have similar effects. Recovery from illness occurs in a way similar to learning. This means that the capacity to perform refers to an otherwise normal state of the organism.

Motivation similarly affects performance. Under conditions of low motivation, learning may occur without any changes in the observed performance. We can reasonably assume that the individual is able to learn action-outcome relations without being motivated to produce specific outcomes when rewards related to outcomes are insufficient or unknown. Motivation is assumed to be a transitory state in the sense that performance drops (improves) as soon as the motivating factors are removed (introduced), whereas competence persists when learning ceases.

Although learning is defined as stable and permanent changes, the present definition of learning does not rule out the possibility of *unlearning* or *decay* of competence. Empirical evidence indicate that competences degenerate if left unused (cf. Argote et al., 1990; Arthur et al., 1998). Decay and relearning should again be distinguished from temporary changes such as motivation, fatigue and recovery.

Learning vs. maturation

Learning should occur as an effect of the individual's relation to *environmental conditions*. This means that learning must take place as a result of practice, experience, training, advice or similar mechanisms, but not through processes of maturation and growth only. At a minimum, something has to happen to the individual for learning to occur. Maturation and growth are the main competitors to learning as the sources of change of capacity to perform.

The capacities and tendency to mature and grow are inherited. The outcomes of physiological growth, for example shape and size, are largely governed by inheritance; this process is however moderated by nourishment, exercise and practice. The environment affects development within a range determined by inheritance. Through the second or third year of life, the vast majority of the brain's development takes place. During this time, the environment to some extent influences the neurophysiological construction of the brain (Hergenhahn & Olsen, 1993). It thus appears to be difficult to classify competences as either completely innate or completely acquired. For example the capacity and tendency to acquire language are clearly inherited, whereas the actual language learned clearly depends on environmental factors, notably mother's language.

According to developmental psychology, the learning process varies across stages of maturation (Hergenhahn & Olson, 1993). During some critical periods the child is particularly receptive to certain kinds of learning, such as learning the mother tongue and learning to walk. Pre-school children are for example able to induce general rules of grammar from a small number of cases of that rule. Children that did not get verbal stimulation during the critical periods have no language and develop rudimentary language only very slowly; they seem to have lost the (inherited) capacity to acquire

human language. Although most scholars agree that both nature and nurture plays important roles, due to such complex interactions among inherited and environmental factors, learning and maturation in children may be difficult to distinguish empirically. In the adult population, skill improvements are readily attributed to learning. Heredity may still be relevant to the extent that it affects the speed of learning, that is, individual learning differences can be attributed to heredity as well as to environmental factors.

B. The study of learning

Being one of the main fields of psychology, a large amount of research on human and animal learning has been generated. The history of research on individual learning is long and diverse. I will make no attempt to present a comprehensive review of this research. I will only indicate the main issues that unite and divide important perspectives on learning.

Most researchers in this field agree that the learning process cannot be studied directly. The nature of learning can only be inferred from observable changes in competence, behavior or performance. Learning is the process that intervenes between input conditions or causes (e.g., experiences) and outcomes (competences or performance). Input variables are assumed to trigger a process that subsequently leads to changes in competences or performance. That is, if variations or changes in outcome variables are empirically associated with certain input variables as described in section A above, we may conclude that this association can be accounted for by learning.

Interpretation, rather than definitions and empirical facts, is the major source of difference between theories of learning. The issues dividing this research are the questions of how knowledge emerges, what is learned and the relation between the sources of learning and the organization of the mind (Bower & Hilgard, 1981). Two opposing positions are usually identified in this area: empiricism and rationalism (see also Hill, 1997).

Empiricism assumes that real-world experiences are the main sources of knowledge, although some knowledge is derived from reflections about relations between experiences. Empiricism is further characterized by *associationism*, the belief that

knowledge elements are connected by associations between experiences that are proximate in time and space. Learning thus occurs through two basic mechanisms: Experience items are stored in memory as simple sense impressions and more complex knowledge items are created by connecting simple knowledge items that coincide in time and space. General associations are created in the mind by recalling and comparing a number of specific associations. This tradition claims that the learner acquires habits or stimulus-response associations. The first experimental investigations of learning were guided by assumptions like these, and the basic features of this tradition remains virtually unchanged during the last 100 years. The behaviorists Pavlov and Skinner are the most widely known representatives of this direction, but the origin of this tradition dates back at least to Thorndike at the turn of the century.

Rationalism assumes that reason (rather than sensory experiences) is the main source of knowledge. Rationalists are primarily concerned with what is going on in the mind of the learner. According to rationalism, sense data are at best raw material to an interpretive mind and these raw data can only be interpreted by means of preexisting knowledge or perceptual assumptions. Rationalists claim that relations among specific experiences are as primary, vivid and real as the specific experiences themselves, that is, the mind is predisposed to organize perceptions in a certain way (notably as cause-effect relations). Rationalists accordingly criticize empiricists for failing to explain how the mind organizes incoming sensory data. This tradition claims that the learner acquires cognitive structures or facts (rather than associations, responses or habits). Although dating back to at least Plato, rationalism is somewhat younger than empiricism as an empirical direction in psychology. Today, the origin of this tradition is usually associated with cognitive psychology and Simon's and associates' computer simulations during the late 1950s (Bower & Hilgard, 1981).

Research on learning within experimental psychology, whether rationalist or empiricist, has captured highly specific learning and memory processes that are not readily translated to organizational settings. Whereas laboratory experiments are designed to identify and isolate a specific process, research in organizational settings must rely on longer and less specified causal chains that operate on larger time scales. A large amount of the details of the learning process studied in the laboratory are inevitably

invisible in field research that operates at a more aggregate level of causation (Cook & Campbell, 1979; Hill, 1997). Laboratory studies of learning are consequently informative only with regard to intervening unobservable processes.

C. The process of learning

Competences may be inherited (develop through growth and maturation), acquired through learning, and develop in interaction between learning and maturation. In the adult population, we can assume that competences are acquired through learning only. Learning has usually been treated as if there is only one learning process. There is, however, reason to believe that there are different learning processes (Bower & Hilgard, 1981; Melton, 1950). The acquisition of psychomotoric skills, for example, involves changes in the memory as well as physiological changes in the body, improvements in a motor task typically involves improved knowledge of facts and cause-effect relations, improved perception and improved muscle strength as well as muscle control and coordination through the nervous system (Noble, 1968). On the other hand, learning about facts and relationships in the environment involves changes mainly in the memory. Thus, the process of learning may depend on the location of the relevant competences in the organism. In this study, I will only be concerned with competences that do not involve psychomotoric skills, such as eye – hand coordination. The issue then is *the process through which the environment affects development of competences that are stored in memory.*

Learning occurs in relation to the person's environment. At a minimum, we must assume that something has to happen to the individual for learning to occur. Information from the environment (sense data, experiences, communication) is the raw material of learning. This can be discussed in greater detail by depicting learning as a chain of intimately connected events, stages or conditions (cf. Bower & Hilgard, 1981). In this study, only a brief outline of the main features is warranted. A number of models or assumptions about how learning takes place within the individual can be constructed and the complete process of learning can be subdivided into stages in a number of ways. The aim is merely to indicate which processes we can reasonably assume to take place.

For learning to occur, information must be available to the person, that is the person must be exposed to information. I define *exposure* as the presence of information in the employee's surroundings. The person is exposed to a piece of information if the information is immediately available to him or her. (Such a piece of information is often referred to as stimulus in the behaviorist tradition.) Exposure to information is the first stage of the learning process. Exposure can depend on the person's prior competence or the person's belief in his or her competence. For example, experts can have a greater ability to search for and process relevant information, and thus increase exposure (Brucks, 1985). Confidence in abilities and knowledge may decrease the search for information, and thus, perceived or imagined expertise may halt learning by reducing exposure to novel information.

Mere availability of novel information is however insufficient for learning to take place. The individual must also direct his or her attention to the information. Only what is perceived can be learned. Thus, *perception* is the second stage of this process. This subprocess is dependent on the person's initial competence. The expert will attend to what he or she knows are the crucial issues and will absorb only the non-redundant (i.e., novel or unexpected) information. The novice will, not knowing what is important, try to attend to everything and will be able to absorb only a fraction of what is attended to. The initial competence will however most likely reduce information search: individuals are less prone to search for information in an area they feel knowledgeable about (Radecki & Jaccard, 1995). Although the expert has more efficient attention and absorption subprocesses, most of the available information will be redundant with regard to learning. For the novice attention and absorption will be less efficient, but a much larger proportion of the information will be useful in regard to learning. On the other hand, initial competence may lead to selective perception that in turn may hamper learning (Dearborn & Simon, 1958).

If information gained through observation and absorption is to be useful at later point in time, it must be retained. Competence increases when the absorbed information is retained within the individual. Thus, *retention of information* can be assumed to be the final stage of the learning process. We can imagine that retention of information occurs as a record of individual data points. This subprocess may also be affected by prior

competence. Experts may for example have a greater capacity than novices to incorporate novel information into a large and sophisticated knowledge structure (Hoch & Deighton, 1989). We can assume that the expert with great speed and accuracy sorts incoming information according to predefined categories.

This study does not intend to observe the details of the learning process. I merely assume that learning takes place as outlined above. No attempt is made to ensure that the process of learning actually occurs as a sequence of the stages outlined. This study focuses on the *informational input* to learning and the *outcomes* of this learning, no attempt is made to actually observe the intermediate process of learning. If inputs to learning relate to outcomes of learning as expected, assumptions about the intermediate processes are supported.

2.2.2 Learning in organizations and the notion of experience

This section outlines previous resarch on learning in organizational contexts. I will in particular focus on the learning outcomes studied and how the learning process as such has been conceptualized in previous research.

Learning outcomes and level of analysis

Previous research on learning in organizations has focused on the increase in productivity with time or cumulative output ("learning curves"; Yelle, 1979). Learning curve studies in organizational or industrial settings have to a large extent measured performance improvements for larger units, such as plants, whole organizations (Argote, 1996) or industries (Sheshinski, 1967). I accordingly distinguish between research on individual learning and learning phenomena occuring at the organization or industry level (see Table 2.1).

Research on learning in organizations has largely ignored what is actually learned by individuals, that is, individual competence outcomes (Hustad, 1996). The right-hand column in Table 2.1 indicates the category of previous research that has in fact been concerned with the actual competence outcomes.

Although learning is defined as a change of *capacity* to perform and the distinction between learning and performance is considered to be crucial, little research has been concerned with what is actually learned. At the individual level, only a small number of published studies of competence acquisition by informal learning exist. Most of these studies relate measures of work-related knowledge and skills to various indicators of experience.

McDaniel et al. (1988) summarized findings concerning the effect of total professional tenure on job knowledge for a total sample of 16,000 employees. In their study, correlations were positive for all jobs. Morrison and Brantner (1992) and Schmidt et al. (1986) found positive effects of time in current job on job knowledge. Similarly, Tubbs (1992) investigated the effects of auditing experience, as measured by years in the trade, on auditor knowledge. Finally, Campion et al. (1994) analyzed the effect of age, organizational tenure, job rotation and promotion on different types of work-related competence – technical, administrative and business competences.

Performance measures have clear limitations as indicators of learning. Several competence types may affect performance in a particular job. An overall performance measure does not distinguish among different competences that might contribute to performance. In addition, learning in a specific job may produce competences that are not particularly relevant to performance in that particular job. A job-related performance measure will not capture this kind of learning. Finally, because performance measures such as output per time unit or percentage of errors may not be available or such measures may not be comparable across observations, performance improvements is not feasible as an indicator of learning in relatively heterogenous samples.

Table 2.1: Learning outcome and level of analysis

	Learning outcome studied	
Level of analysis	**Performance (productivity)**	**Competence**
Individual employee	Individual learning curves (Thurstone, 1919; Yelle, 1979); job experience effect on job performance (McDaniel et al., 1988); effects of experience and training on different types of performance (Motowidlo & Scotter, 1994); experience, performance and earnings (Medoff & Abraham, 1980); experience and managerial performance (McEnrue, 1988; Fiedler, 1995)	Tenure and job rotation effect on different types of competence (Campion et al., 1994); technical and non-technical competences (Arnold & Davey, 1992); job experience effect on job knowledge (Schmidt, Hunter & Outerbridge, 1986; Morrison & Brantner, 1992); experience effect on knowledge in specific professional field (Tubbs, 1992); professional tenure and job knowledge (McDaniel et al, 1988)
Organization/ Industry	Organizational learning curves (Yelle, 1979); progress functions (Dutton, Thomas & Butler, 1984); industry-level learning curves (Sheshinski, 1967)	Resource based theory of the firm (Kogut & Zander, 1993; Prahalad & Hamel, 1990; Markides & Williamson, 1996); organizational aggregates of individual training (Nordhaug, 1991)

The notion of experience

Research on learning curves in organizations (whether at the individual or organizational level) has shown that repeated execution of the same task causes increased competence in handling that task, as measured by improved performance (notably output per time unit) (Yelle, 1979). Most of these studies have been concerned with various specifications of experience, with the functional form (mathematical specification) of the learning curve, or with estimates of the learning curve parameters for various types of products and types of manufacturing. More recent research has captured the effects of competence spillover from other shifts at the same plant (Epple et al., 1991) and from distant divisions in the same organization (Darr et al., 1995). Time and cumulative investments have been used as alternatives to cumulative output volume as measures of experience. Less attention has been paid to the question of *why* performance improves and to the details of *what* is actually learned.

Human capital economists assume that experience (as measured by time) reflects on-the-job training which in turn causes performance improvements. This is assumed to explain why more experienced workers receive higher wages than comparable workers who have spent less time in the labor force (Medoff & Abraham, 1980; Maranto & Rodgers, 1984). Beyond assumptions about on-the-job training, human capital

economists tend not to make any specific assumptions about the intervening learning process or about the content of experience.

Psychologically oriented researchers have been concerned with career history and accumulation of experience (Morrison & Hock, 1986), job experience and job performance (Fiedler, 1995; McDaniel et al., 1988), experience and task proficiency (Lance et al., 1989), time needed to learn a job (Morrison & Brantner, 1992; Pinder & Schroeder, 1987), and job rotation effect on knowledge and skills (Campion, et al., 1994).

Although empirically successful and of substantial practical importance, most of the learning-from-experience research has proceeded without a clear theoretical orientation (cf. Tesluk & Jacobs, 1998). More specifically, experience has been defined and measured as one-dimensional, for example years in job or years in organization or cumulative output (Quiñones et al., 1995). The concept of experience has largely been taken for granted or equated with whatever empirical measures were available. Rarely is any effort made to distinguish between specific operationalizations and a general theoretical concept corresponding to "experience". The central role of experience in informal learning has apparently been regarded as self-evident. Experience has mainly been defined by specific operationalizations rather than by theory.

The actual mechanism of learning from experience has remained implicit. Previous research has thus suffered from two closely related shortcomings: Lack of a general concept capturing the phenomena informally referred to as "experience" has limited the scope of factors that can actually serve as operationalizations of "experience". Lack of an explicit theoretical understanding of the mechanisms relating experience to competence makes it difficult to relate different types of experience to different types of competence.

"Experience" is frequently used in a common-sense fashion incorporating the conditions or events giving rise to learning as well as that which is learned. This calls for a clarification of the notion of experience. Little is known about the *content of experience* measured in terms of time or volume. Previous research has used time-based measures of experience at different levels of specificity, for example time in job, firm or

occupation. The theoretical significance of differences among such levels have not been elaborated.

Research reported by McCall, Lombardo and Morrison (1988) focuses on singular instances of experience rather than coarse measures of accumulated experience. McCall et al. argue that some events (instances of experience) pack more developmental punch or learning potential than others. The actual content of experience that McCall et al. emphasizes is a neglected issue in research on learning in organizations. Quinoñes et al. (1995) similarly calls for greater attention to type, quality or characteristics of experience as well as the specificity of measurement (e.g., job, organization), this framework is further developed by Tesluk & Jacobs (1998).

Quinones et al. (1995) proposes three nested levels of specificity: task, job and organization. Tesluk & Jacobs (1998) extends Quinones et al.'s classification and proposes five levels: task, job, work group, organization and occupation. The latter model is not, however, perfectly hierarchical. Tasks and jobs may be classified in terms of organizational as well as occupational affiliation. Most organizations employ people from a number of different occupations or professions. Most occupations include members employed in a variety of organizations. Organization and occupation should thus be regarded as independent (perpendicular) dimensions (see McEnrue, 1988, for an example).

The fundamental assumption of this study is that time, volume and other measures of experience are mere proxies to the amount of work-related information the individual has been exposed to. "Experience" implies that the person has done something or been exposed to something. It is the informational content of these events or conditions that gives rise to learning. As discussed in section 2.2.1, it is the information (about what happened, how it happened, who made it happen, about the state of the world etc.) picked up along the way that is eventually transformed into competence. It is not time or volume as such that generates learning, but time or volume is an indirect measure of *how much* information the employee is exposed to. Quiñones et al. (1995) and Tesluk & Jacobs (1998) consider volume, time and type of experience (e.g., task difficulty) as measurement modes. The amount of information and the quality of information (such as

task difficulty) are more than different measurement modes, they are conceptually different. The learning effects of amount as opposed to quality are most reasonably different.

Quiñones et al. identifies further crucial issues in regard to research on experience and learning: Experience can be measured at different levels of specificity (e.g., job, organization) and experience is context-bound (related to for instance an organization or an occupation). This implies that research should decide on the appropriate *partition* (or categorization) of experience along dimensions of *domain* (or context) as well as *specificity*. The appropriate partition should depend on theoretical linkages between experience and outcomes of interest, rather than on available measures.

By extending previous frameworks (Quiñones et al., 1995; Tesluk and Jacobs, 1998), I generalize the notion of experience into a concept of exposure to work-related information. This means that I consider accumulation of experience as a special case of accumulated exposure to work-related information (see also section 2.2.1). (Due to the conceptual imprecision and common-sense connotations of "experience" I decided to avoid this term.) The purpose of this study is accordingly to study the effects of *informational input on competence outcomes*. I will not consider other aspects of the learning environment. Compared to traditional measures of experience, a general notion of exposure to information allows a range of indicators to be used as measures of information input. The challenge is then to identify relevant types of information exposures as well as develop empirical measures.

My point of departure is that learning is related to characteristics or the contents of this information, that is, competence development depends on *what* information the person is exposed to as well as *how much*. Variations in employee information exposure should accordingly be related to variations in employee competence acquisition. An appropriate theoretical framework should thus specify relevant dimensions or domains of information exposure as well as how these can be expected to relate to different competence outcomes. This study differentiates information according to the work-related domain to which the employee is exposed and relates this to the three competences identified above.

In the sections below, I try to contribute to such a framework by outlining *general properties of the relation between information exposure and competence acquisition* in terms of three propositions. I then identify a set of *indicators of exposure* and specify testable hypotheses for each indicator. 3

2.3 Propositions and hypotheses

This section outlines general propositions about effects on different types of competences, identifies relevant explanatory variables and specifies testable hypotheses relating each of the explanatory variables to each of the outcome variables.

Figure 2.3 outlines the relations to be discussed in greater detail in the sections below.

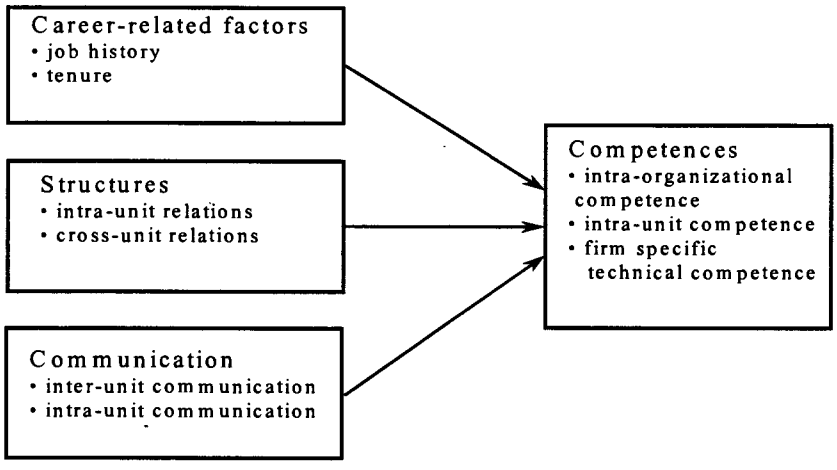

Figure 2.3. ***Model***

This study investigates how and to what degree employee competences are affected by exposure to work-related information. I expect that the content of the information is associated with what is learned. This study includes learning in three specific domains: firm specific technical competences, intraorganizational and intraunit competences. It is generally expected that exposure to domain-specific information will contribute to the corresponding domain-specific competence. In the three following paragraphs the effects of accumulation, the diminishing effects of accumulation and the different effects on different competences will be discussed. The following sections (2.3.1-2.3.3)

identifies a set of indicators of exposure to each domain and on this basis specifies testable hypotheses. For each explanatory variable, there are generally three sets of hypotheses each corresponding to the three general propositions stated below. Whereas I assume the three propositions as premises for each set of hypotheses, each explanatory variable will also be discussed in relation to previous research.

1. Accumulation effects

As indicated in section 2.2 my point of departure is that experience, as operationalized in previous research (notably learning curve studies), is a proxy for the amount of information the individual has been exposed to. Learning is then assumed to proceed by absorbing and processing this information, and revising, updating or complementing one's competence (cf. Mazur & Hastie, 1978). Learning is a time and path dependent process. Learning curve studies and similar research on the effects of experience demonstrate that it is the accumulated experience with a task that critically affects competence. Behaviorists interpret learning curves as a strengthening of associations or memory traces (Wickelgren, 1981). As experience accumulates, associations or response tendencies become stronger.

Beyond the behaviorist-experimental tradition, little theoretical and empirical work has accounted for why accumulated experience affects competence and performance. The notion of accumulation invokes a metaphor of collecting or filling up. The more experience you get, the more knowledge and skills you have. In the present context, that which is accumulated should not be equated with that which is learned. As discussed in the preceding section, several subprocesses must be effective for a piece of information to contribute to the person's competence. Due to inattention, forgetting, inefficient retrieval and insufficient processing, a piece of information may not make an optimal contribution to the person's competence.

In the context of a workplace this means that once the employee receives information (for example by observing or by being told) about an issue, the employee will or can start building competence related to this issue. The more information the employee

receives (accumulates), the more knowledge and skills he or she may potentially develop.

In this context, I interpret accumulation as follows: the more information one has been exposed to, the more one may potentially have learned. Accumulated exposure is all the information made available to a person, not that which is stored and transformed into competence. Learning occurs within domains of varying types and degrees of specificity. Through learning, some of the information within a domain may ultimately give rise to competences in that domain. I accordingly assume that information specific to a domain affects competences specific to the same domain. The amount of accumulated exposure to a domain is positively related to the level of competence in that domain:

Proposition 1: Accumulated exposure to information positively affects domain-specific competences.

2. Diminishing effects

There are two robust empirical findings from research on learning curves: performance increases as experience accumulates (see preceding paragraph), and the rate of increase in performance decreases steadily as experience accumulates. In other words, the effect of time (or other measures of accumulated experience) is decreasing with time (Mazur & Hastie, 1978; Yelle, 1979). I interpret this as follows: As information exposure accumulates, the non-redundant information is gradually exhausted and the probability of encountering novel information is steadily falling. Each unit of time (or other measures of information exposure) will contain less novel information as information exposure accumulates. The amount of novel information received during a unit of time determines the maximum possible learning during that period. The rate of learning should accordingly be highest at the outset and then gradually decreasing.

As the learner builds a progressively more complete model of the environment, the probability that the next piece of information becoming available to the learner matches the remaining holes in the model is falling and gradually approaching zero. In stable environments, we might assume that the learner will eventually know everything about

a specific subject and additional information will cease to have an effect on competence. When competence reaches (or approaches) maximum no more learning will occur. In the words of the economist, learning is subject to diminishing returns from experience and asymptotically approaching an optimal response pattern (Arrow, 1962). That is, the rate of learning should be decreasing and approaching zero ("plateauing"). My second proposition thus concerns the functional form of the relation between exposure and acquired competence. This proposition incorporates (a) that learning occurs at a decreasing rate and (b) that learning is asymptotic:

Proposition 2: (a) Accumulated exposure to information within a domain has a diminishing effect on domain-specific competences.
(b) This effect approaches zero as exposure to information accumulates indefinitely.

3. Differential effects

Previous research on organizational learning curves has primarily investigated the plant, department or unit level. The kind or content of learning at the individual level has generally not been specified. This study distinguishes several firm-specific learning outcomes at the individual level. Previous research has not been sufficiently explicit about how the specificity of experience is related to learning outcomes (Quiñones et al., 1995). Quiñones and associates' meta-analysis indicates that more specific measures of experience are better predictors of job performance. This suggests that more specific measures of experience is a more accurate measure of accumulation of information relevant to learning in a particular domain. Fiedler (1995) summarized studies investigating the effects of different levels of specificity of experience on leadership performance. Time-based measures of experience (time in service, time in department, time as leader and time in job) all correlated to a varying degree with leadership performance, whereas technical training had a median correlation close to zero. These studies suggest that experiences in different domains have different effects on different performance measures.

Similar research on personnel selection and multidimensional performance measures indicate that different dimensions of work performance have a different set of

determinants (McCloy, 1994; Motowidlo & Scotter, 1994). A study of task and extra-task performance (Hattrup et al., 1998) demonstrated that different personality characteristics had unique relations to different dimensions of work performance. Different antecedent variables in other words differentially affects different performance outcomes.

The type of research on performance outcomes discussed above implies complex theoretical predictions: In addition to the effect of an antecedent variable (x) on outcome variables (y and z), this research implies that there is a *difference* between the effect of x on y and the effect of x on z. However, few formal tests of such *differential effects* have been reported. This may be due to an absence of standardized tests or a lack of appropriate data.

We can imagine that a single piece of information ("micro-experience") is related to one and only one learning outcome. This may be true to the extent that we are in fact able to break down all information available to the employee into its smallest constituent parts and classify each piece of information according to the only type of competence it is related to. In management as well as in quantitative empirical research this is not feasible and probably impossible. We rely instead on indirect and coarse measures of information exposure. These measures are not pure in the sense that they capture learning related to one and only one competence outcome. Each instance of information exposure can produce more than one learning outcome. If for example an employee completes a task in cooperation with a co-worker, the employee may learn task-specific skills, may learn about cooperation as well as gaining knowledge about that specific co-worker. These different aspects of the informational input to learning are difficult to separate. We may however be able to guess in which domain *most* learning will take place. Some types of exposure may contribute equally to learning outcomes, whereas other types may contribute mostly to one type. The challenge then is to identify to which domain a measure of information exposure is most related.

In general, I assume that a measure of information exposure is more related to learning outcomes at the corresponding level of specificity and less related to other outcomes. Organization-level measures such as tenure and intraorganizational mobility will be

more related to intraorganizational competence than to unit- or task-specific competences. Similarly, task-related measures of accumulated information exposure will then be more related to firm-specific competence outcomes than to intraorganizational or intraunit competence. That is, exposure to a domain is expected to be *differentially* related to different competence outcomes:

Proposition 3: (a) Accumulation of information exposure affects different competences differently.
(b) Accumulation of information exposure in a domain has a larger effect on domain-specific competences than on other competences.

This may have important implications. If different types of competences have different determinants (and, most likely, different performance consequences), then the competence typology suggests important, differential causal paths (Hattrup et al., 1998; Motowidlo et al., 1997; Murphy & Shiarella, 1997). If learning affects all competences equally, distinctions among competence types would be a purely theoretical exercise and would not be empirically informative. That is, if different types of competences relate to different antecedents (e.g., experience, training) or different outcomes (for example in terms of types of performance), the competence typology has both practical and theoretical value (see also Conway, 1996).

Summary and overview of explanatory variables

In the preceding paragraphs I discussed three different aspects of the effects of information exposure on competences: the effects of accumulation, the diminishing effects of accumulation and differential effects. Each property of the relations between explanatory and outcome variables is specified as a theoretical proposition. The sections below develop these propositions in greater detail. I will in particular specify variables that allow all three propositions to be tested. Each proposition is related to a set of hypotheses. For proposition 1 and 2 there is a subset of hypotheses for each outcome variable.

The employee may be exposed to information in several ways. In a perfectly isolated work environment with a constant job this will be a purely time- or volume-dependent process. That is, time or volume determines how much work-related information the

employee has been exposed to. This information mainly includes the employee's own observation of task execution, results and so forth. These measures of exposure have been extensively studied in previous research.

Information can also originate in other ways. Direct communication with other employees may increase the amount of novel information. Communication among employees may involve help, advice, "know-who", benchmarks, various task-related details and so forth. Because most work environments are far from perfectly isolated, previous research has probably captured some of the effects of communication in time or volume variables. A change of job involves a change of the employee's information environment, such as different tasks, new colleagues or different equipment. The effects of intraorganizational mobility have probably been picked up by the time and volume variables applied in previous research. In addition to the above, organizational structure may provide a channel for information flow. Structures overlaid on the traditional hierarchy, teams, projects and matrix-type structures for instance, are particularly relevant in this context. Again, the effects of such structures may have been incorporated in the time or volume based learning curves.

Based on the above I decided to operationalize exposure to work-related domains in three different ways – each of these involves a set of independent variables. First I included a traditional measure of career-related experience: time. In addition I included the number and characteristics of job changes as another career-related measure of exposure. Then I reasoned that organizational design structures the employee's information environment, and included some aspects of formal design. Finally, I decided to incorporate direct measures of information flows in different domains. In order to test proposition 3, I selected variables and designed measures to be as specific as possible with regard to different domains.

Section 2.3.1 will discuss the accumulation of information exposure along the employee's intraorganizational career path. The following section deals with information exposure due to the intra-unit and cross-unit relation in which the employee is engaged. Tenure, career and organizational structures are relatively indirect measures of information exposure. The employee's actual communication with co-workers is a

more direct measure of the information made available to the employee. Section 2.3.2 discusses the possible effects of communication among co-workers. Hypotheses derived from each of the three propositions will be summarized and presented in section 2.4. Due to the substantial number of explanatory and outcome variables, a large number of hypotheses will be developed and tested.

2.3.1 CAREER-RELATED FACTORS

An individual's competence in a specific domain is assumed to be a function of accumulated exposure to that domain. Firm specific competences should thus be a result of exposure to various intraorganizational domains. Employee intraorganizational work-history includes several aspects of accumulated exposure to organizational domains, and I will in particular focus on two salient features of an intraorganizational career: Time and the sequence of jobs held.

Intraorganizational job history

In addition to tenure, patterns of job transitions are among the most salient features of an individual's career. The number of different jobs during the employee's relation with the organization adds to the exposure to intraorganizational domains. An employee who has an intraorganizational history of many jobs has probably been exposed to a larger variety of information than an employee with a shorter track record has (Kanter, 1988). There has been surprisingly few studies concerning the effects of career on work-related competence.

An intraorganizational job transition may occur for several reasons. A transition may be part of a trainee program, internal recruitment to vacancies may trigger a chain of transitions, reorganizations and organizational growth may create new jobs, and variations in manpower demand in different units may require that employees are transferred among units from time to time. Assigning employees to a trainee program is clearly motivated by expected learning outcomes. Employees may apply for jobs that are expected to involve competence-boosting experiences. Transfers may also be incorporated into a policy for corporate knowledge sharing and diffusion (Cerny, 1996;

Prahalad & Hamel, 1990). Aase (1997) reports qualitative evidence that personnel rotation is or can be an effective vehicle for knowledge distribution within an organization. There is, however, no rigorous empirical research in this field and Huber (1991) accordingly concludes that the effect of internal employee transfer on intraorganizational information distribution is a prime candidate for empirical study. Job changes should not, however, be distinguished by their causes or motives, but rather by characteristics of the job transition itself.

In spite of widespread belief in the virtues of a variety of job experiences and job transitions, little systematic empirical research exists that test these beliefs. Job rotation has for a long time been assumed to be an effective component in management development. Similarly, personnel transfer in multinational corporations is an important ingredient in management development (Edström & Galbraith, 1977) and technology transfer (Grosse, 1996). In spite of early theoretical developments (Edström & Galbraith, 1977; Brett, 1984; Pinder & Walter, 1984), little attention has been paid to the consequences of transfer on individual competence. Most of the research on these issues has, however, addressed employees' willingness to accept a (employer initiated) transfer (Brett et al., 1993), transferee satisfaction (Brett, 1982), and post-transfer adaptation (Pinder & Schroeder, 1987) or socialization (Van Maanen, 1982). Although Van Maanen emphasizes learning taking place after a boundary crossing, he only discusses job-specific learning outcomes.

Katz (1982) argued that job tenure is related to increased commitment to established practices, increased selective exposure and selective perception, and increased reliance on own expertise. Thus, transfers may increase learning by breaking such a vicious cycle. Gupta (1984) argued that general managers with functionally diverse career histories, due to reduced functional-area blindness, "myopia", will make the greatest contribution to their organization's effectiveness. West & Nicholson (1989) investigated the relationships between different types of job changes and a number of outcome variables. They found that upward changes (promotions) were related to increased opportunities for growth whereas lateral and interorganizational moves (change of employer) were not.

Conventional wisdom holds that knowledge is absorbed and skills are developed along the career trajectory. In the intraorganizational context, Campion et al. (1994) found that job rotation (job transition without promotion), but not promotion, enhances skills and knowledge. Job rotation was positively associated with administrative (including planning, communication, leadership and cognitive skills) and business competences (including knowledge of business and environmental issues), but was not associated with technical competences. Beyond suggestions that rotation "increases experience" or "provides varied experience", Campion et al. were not specific about why job rotation increases learning.

Another stream of research has focused on promotions and other job transitions. Although frequently used as an indicator of experience in general and managerial skills in particular, little systematic research about the relation between promotions and competence exists. Theoretical developments suggest that career has an impact on competence (Dalton, 1989; Morrison & Hock, 1986), but lack specificity with regard to causal mechanisms and relations. Published empirical research emphasizes the effects of job transition characteristics (rather than the frequency or number of transitions as such) on learning (Davies & Easterby-Smith, 1984; McCauley et al., 1994). Surprisingly, Morrison and Brantner (1992) found that the number of previous jobs did *not* have an effect on the time it takes to attain proficiency in the current job. Campion and associates (1994) did *not* detect any effect of promotion rate on any of three different types of competence outcomes (technical, business and administrative competence). Both findings suggest that previous jobs do not produce competences that the employee can utilize in subsequent jobs.

Although rarely explicitly stated in published results, I interpret previous research as involving the effects of different types of exposure. In order to capture extent of exposure to corporate and unit environments, I distinguish between two types of job changes: Change of job within the unit (*job transitions*), and change of job that involves a transfer between units (*cross-unit transfer*). The two types of job changes are expected to contribute differently to different competences.

Cross-unit transfers increase the employee's contact with different parts of the organization. The employee can be exposed to information both during the time of his or her assignment to a specific unit and through personal relations that may have developed and that persist when the assignment has terminated. In this way the employee can learn about different parts of the organization, about the people there, about their activities and their skills. By moving around the employee can learn about organizational structure and about how different parts of the organization are related. This can contribute to intraorganizational competence. In addition, the employee can obtain more varied experiences with methods, ecquipment and installations as well as specific operating conditions. I assume this will add to firm-specific technical knowledge. The more cross-unit transfers the employee has done, the more intraorganizational and firm-specific technical knowledge the employee is expected to acquire:

Hypothesis 1: *The number of cross-unit transfers is positively related to the level of intraorganizational competence.*

Hypothesis 2: *The number of cross-unit transfers is positively related to the level of firm-specific technical competence.*

Because the effect of cross-unit transfers is assessed by recording the number of such transfers, the functional form of this relation can be investigated (provided that the variation in the number of cross-unit transfers is large enough to make such a test sufficiently sensitive). A transfer places the employee in a new work environment and the employee gets the opportunity to learn something new. The first transfer exposes the employee to novel information regarding organization, methods and so forth. The second transfer normally provides less novel information because more will or may be known from previous assignments. Thus, each successive transfer provides less and less news to the employee. According to Proposition 2 relations with outcome variables should be diminshing and asymptotic:

Hypothesis 3: *The relation between the number of cross-unit transfers and the level of intraorganizational competence is (a) diminishing and (b) approaching zero as the number of cross-unit transfers increases.*

Hypothesis 4: *The relation between the number of cross-unit transfers and the level of firm-specific technical competence is (a) diminishing and (b) approaching zero as the number of cross-unit transfers increases.*

I expect transfers or rotations to be a more effective vehicle for learning about the organization as whole than for learning about task-related methods and ecquipment. Although I expect both outcomes to be affected, variations across units with regard to intraorganizational issues (e.g., people) can be expected to be larger than variations in information regarding firm specific methods, ecquipment and so forth (see Proposition 3; cf Campion et al., 1994). Thus, I expect the effect of transfers on intraorganizational competence to be larger than the effect on firm specific technical competences:

Hypothesis 5: *The relation between the number of cross-unit transfers and the level of intraorganizational competence is stronger than the relation between the number of cross-unit transfers and the level of firm-specific technical competence.*

I assume mobility *within the unit* to increase the employee's access to information about various aspects of the unit. This includes contact with more people, information about structures and activities, as well as politics and decision making. Because these issues are related to both the unit and the organization as a whole, I expect that job changes within units affect both intraorganizational and intraunit competence. As for cross-unit transfers, this variable is recorded as the number of job transitions:

Hypothesis 6: *The number of job transitions is positively related to the level of intraorganizational competence.*

Hypothesis 7: *The number of job transitions is positively related to the level of intraunit competence.*

On average, the first job transition can be expected to provide the most novel information to the employee. After having had a few jobs we might assume that the employee has acquired extensive knowledge about the unit and the organization. Thus, as stated in Propositon 2, the learning effect of another job will eventually wear off. As

for cross-unit transfers, the measurement of this variable allows a test of functional form:

Hypothesis 8: *The relation between the number of job transitions and the level of intraorganizational competence is (a) diminishing and (b) approaching zero as the number of job transitions increases.*

Hypothesis 9: *The relation between the number of job transitions and the level of intraunit competence is (a) diminishing and (b) approaching zero as the number of job transitions increases.*

I assume mobility within the unit to increase the employee's access to information about various aspects of the unit. This includes contact with more people, information about structures and activities, as well as politics and decision making. Although these issues are related to both the unit and the organization as a whole, I assume that intra-unit job moves increase the exposure to the unit more than it increases exposure to the organization-wide environment. Because the unit is smaller than the organization as a whole, each piece of information will contribute relatively more to intraunit than to intraorganizational competence. We should thus expect the effect of intraunit mobility to be largest with regard to intraunit competence. According to Proposition 3 I state the following:

Hypothesis 10: *The relation between the number of job transitions and the level of intraunit competence is stronger than the relation between the number of job transitions and the level of intraorganizational competence.*

Tenure

Experience is frequently equated with time, for example time in position, time in organization or time in profession or field of practice. Previous research has generally failed to specify the content of experience and actual competence outcome.

Previous research at the individual level of analysis has in particular investigated how time affects performance in a specific job, for example the effect of time in a job on job

performance (Schmidt et al., 1986), the effect of job experience (months in service, months in present unit, months of experience with specific technology) on task proficiency (Lance et al., 1989), and the effect of total professional or occupational tenure on job performance (McDaniel et al., 1988). Past performance has been shown to predict performance in a new job better than seniority, the predictive ability of seniority did, however, increase with increasing similarity between jobs (Gordon & Fitzgibbons, 1982). This suggests that the task-specificity of tenure is associated with task performance. In a sample of police officers and firefighters, performance improved with tenure but plateaued after about five years of job experience (Jacobs et al., 1990). Research on performance in challenging tasks, such as chess or medical practice, indicate that even for the most talented individuals about ten years of daily practice is needed to reach expert level (Ericsson & Lehman, 1996).

Another stream of research has studied the effect of time in profession, time with the organization, the effect of time in current unit (McEnrue, 1988), and the effect of time as a manager (Borman et al., 1993; Fiedler, 1970) on *managerial* performance. McEnrue (1988) found that time in profession, but not time with the organization or in current unit, affected business performance. In an experiment with marketing managers, Perkins and Rao (1990) found that experience was an important determinant of decision making strategy and decision outcomes for relatively unprogrammed decisions. Borman and associates (1993) found positive relations among supervisor tenure, knowledge and rated performance, whereas Fiedler (1970) found that supervisor tenure had no or a slightly negative relation with work group performance. Fiedler (1995) summarized a number of studies investigating the effects of training, experience and abilities on leader performance, and concluded that experience and intelligence positively affect performance whereas technical training on average has no effect on performance. More recently, research on the effects of years of experience on different types of performance (notably task and contextual performance) has been reported (Motowidlo & Scotter, 1994).

In addition, human capital economists have studied the effect of total work experience and company tenure on performance and current salary (Medoff & Abraham, 1980,

1981). Medoff and Abraham demonstrated that wage growth was clearly associated with tenure, although performance did not improve accordingly (there were also indications of a negative relation between tenure and performance). Using an objective individual performance measure, Maranto and Rodgers (1984) found that previous experience and job tenure as well as education had a positive effect on performance. Employees became substantially more productive during the first six years in the job.

A small number of researchers have studied the effect on competence as such. McDaniel et al. (1988) summarized findings concerning the effect of total professional tenure on job knowledge for a total sample of 16,000 employees – correlations were positive for all jobs. Correlations did, however, drop sharply as tenure increased (suggesting a diminishing effect of tenure), and correlations were larger for low complexity than for high complexity jobs. Morrison and Brantner (1992) and Schmidt et al. (1986) found positive effects of time in current job on job knowledge. Schmidt and associates found job experience to be a better predictor of job knowledge and job performance than general cognitive ability. Similarly, Tubbs (1992) investigated the effects of auditing experience on auditor knowledge. Although basic findings should be comparable across organizations, jobs and professional fields, research methods specifically designed for a highly specialized field such as auditing are not transferable to other fields. Finally, Campion et al. (1994) analyzed the effect of age and organizational tenure on different types of work-related competence – technical, administrative and business competence – but did not find any significant relations.

Previous research has generally failed to explicitly adress *why* time is or should be related to learning outcomes. The importance of experience in terms of time has largely been taken for granted. As discussed earlier, I interpret time as merely as a crude measure of information exposure. Rather than recording the effect of time as such, previous research has mainly measured accumulated information exposure. This is also related to the inadequate attention to the appropriate specification and measurement of time. Previous research has in general not explicitly discussed the appropriate specificity of the time variable, for instance if time in job or time in company is the most relevant predictor of learning and performance. Nor has previous research explicitly discussed if

measures at different levels of specificity might be related to different learning outcomes.

Time-based measures of experience can be used at various levels of specificity, for example time in profession, time in company or time in current job. Learning outcomes can also be specified at various levels such as knowledge about company or job knowledge. Earlier empirical research does indicate that the specificity of tenure is associated with the specificity of outcome measures (see Proposition 3). Similarly, total work tenure should have less effect on job specific knowledge than time spent in the current job. This study accordingly specifies time variables at the same level as the outcome variables. Two time-based measures of information exposure are used: *organizational tenure* (time with the organization) and *unit tenure* (time in current unit). Based on previous research as well as extensive discussion throughout this thesis, I expect organizational tenure to affect intraorganizational as well as firm-specific technical competence. Because there is a separate measure for unit tenure, I do not expect that intraunit competence will be related to organizational tenure:

Hypothesis 11: Organizational tenure is positively related to the level of intraorganizational competence.

Hypothesis 12: Organizational tenure is positively related to the level of firm-specific technical competence.

Tenure is a coarse measure of accumulated information. The first day at work in a new organization typically involves large amounts of novel information. Each successive day, the employee will encounter somewhat less novel information. Eventually there is not much more to learn and the learning effect of time wears off (Proposition 2):

Hypothesis 13: The relation between organizational tenure and the level of intraorganizational competence is (a) diminishing and (b) approaching zero as tenure increases.

Hypothesis 14: The relation between organizational tenure and the level of firm-specific technical competence is (a) diminishing and (b) approaching zero as organizational tenure increases.

Although one finding in previous research (Campion et al., 1994) suggest that tenure is more related to intraorganizational than to firm-specific technical competences, little research has adressed differential effects of organizational tenure. Each unit of time spent within an organization will to some extent involve information regarding intraorganizational issues. We can assume that most employees are not constantly occupied with purely task-related issues. Accordingly, each unit of time may not necessarily involve information regarding task-specific issues. For each unit of time the probability of encountering novel information regarding organizational issues should then be larger than the probability of encountering novel information regarding technical issues. On average we can assume that cross-unit communication increases exposure to the organizational more than it increases exposure to technical domains. I accordingly expect the effect of organizational tenure to be largest with regard to intraorganizational competence:

Hypothesis 15: The relation between organizational tenure and the level of intraorganizational competence is stronger than the relation between organizational tenure and the level of firm-specific technical competence.

In addition to organizational tenure, I consider the impact of unit tenure. Because organizational tenure is the sum of all unit tenures (including current unit), there is considerable overlap between organizational tenure and unit tenure. As a more specific measure I assume unit tenure to be mostly related to the more specific type of competence (Proposition 1). I expect unit tenure to affect the level of intraunit competence, but none of the other outcomes:

Hypothesis 16: Unit tenure is positively related to the level of intraunit competence.

As for organizational tenure, the effect of unit tenure on learning is expected to diminish and plateau when unit tenure increases (proposition 2):

Hypothesis 17: The relation between unit tenure and the level of intraunit competence is (a) diminishing and (b) approaching zero as tenure increases.

2.3.2 ORGANIZATIONAL STRUCTURES

In this section I discuss how organizational structures channel the employee's exposure to different parts of the intraorganizational environment. I will assume that there are basically two types of formal relations within an organization: Vertical and horizontal. Vertical relations connect superiors and subordinates in a chain-of-command structure. All organizational employees and units are connected through a common superior. Horizontal (or lateral) structures connect employees and units in other ways than through the common manager. Whereas vertical relations are multi-purpose channels, horizontal relations are usually shortcuts designed for specific purposes. We can readily assume that all employees are involved in a vertical relation, whereas the kind and extent of horizontal relations varies across employees. I will accordingly focus on how variations in *horizontal* relations are related to variations in competence acquisition. These are the overlaid structures not generally shown on the organizational chart.

Different types of horizontal structures can affect exposure in different ways. I differentiate horizontal relations along two dimensions: 1) the extent to which the relation spans distant parts of the organization and 2) the extent to which the relation involves other functional areas. Cross-unit relations may connect professionals working the same field, and they may be established in response to corporate-wide problems or projects. Intraunit relations cover the regular, daily cooperation within the department or unit. Cross-functional relations often arise in relation to work interdependencies, problems or specific projects, whereas intra-functional relations often arise in relation to narrow tasks or specific professional fields. In the present context, these can be combined into four main types as shown in Figure 2.4. The degree to which the employee is involved in a relation defines a variable. The paragraphs below deal with each type.

	Intraunit relations	Cross-unit relations
Functional	Intra-functional cooperation Teams	Professional relations
Cross-functional	Teams Cross-functional cooperation	Task forces

Figure 2.4: Types of horizontal relations included

Cross-unit relations

Lateral professional relations

Conventional theory about organizational design assumes that the best design is one that minimizes coordination costs through unit grouping and coordination mechanisms (Mintzberg, 1979). Recent theoretical developments suggest that conventional prescriptions do not take into consideration learning dynamics within multidivisional organizations (Cerny, 1996; Markides & Williamson, 1996; Prahalad & Hamel, 1990). In multidivisional organizations, similar activities are performed in separate and often distant units. Learning may thus occur independently at different locations and accumulated knowledge will not be shared unless some diffusion mechanism is operating (Chew et al., 1990; Huber, 1991; Levinthal & March, 1993).

Diffusion often occurs as an unintended by-product of other activities, for example personnel transfer (see also section on career-related factors) and task-related cooperation. Contrary to conventional wisdom that blames motivational or incentive mechanisms, Szulanski (1996) found that the major barriers to intra-firm diffusion of knowledge are structural and knowledge-related. In addition to ignorance (about sources of information) and capacity to absorb knowledge, lack of a relationship between the source of knowledge and the potential recipient of knowledge was a major impediment to the transfer of knowledge between parts of the organizations. Based on qualitative data gathered within a Norwegian oil company, Aase (1997; cf Husemoen, 1997) concluded that company size, company age[2], project organization, geographical dispersion and work fragmentation are the most important barriers to transfer of

[2] In a relatively young company/industry, professionals with experience in various parts or phases of petroleum production are not available.

experience based knowledge. Making mistakes twice and duplication of development activities were notable consequences of inadequate transfer. Hansen (1996, 1999) studied the effects of relations among units on knowledge sharing in a multiunit company. Using project completion time as a performance measure, project teams in a central network position (with respect to units possessing related knowledge) obtained knowledge more effectively. Hansen's findings also indicate that weak cross-unit relations have a dual effect on project completion time. Weak ties improved the search for useful knowledge in other subunits but impeded the transfer of complex knowledge (noncodified and dependent knowledge).

Some large (multinational) corporations acknowledge this problem and have implemented structural remedies, notably matrix-type (lateral) relations across divisional borders. Students of multinational corporations have recently described multinational corporations as a network of relations among subsidiaries, and point to the extensive use of lateral relations among subsidiaries in many multinationals (Ghoshal & Bartlett, 1990). Although an important practical issue both from the perspective of the employee and the company, only fragmented empirical evidence about learning effects has been reported.

Formal and informal networks, although often described as opposites, overlap considerably (Ibarra, 1992). We can assume that networks (sum of formal and informal relations) are of a substantially higher density within units than across such that boundaries between subunits act as barriers to information flow. A *formal* lateral relation may then establish an effective connection to more distant parts of the organization (cf. Granovetter, 1973, 1982). Exposure to non-redundant information should consequently increase.

These formal lateral relations often have the dual purpose of managing personnel across unit borders (see section on transfer) and integrating dispersed competence. The director of each corporate staff will usually be the manager of a lateral relation. The vice president of finance, for example, will then be heading the lateral relation connecting finance officers throughout the organization (including the corporate finance staff).

Employees affiliated with such a relation should thus be better informed about activities within their function or profession across units. There is, as indicated above, no research on the effects these lateral relations have on competences. As a cross-unit relation these relations can be expected to increase the employee's exposure to the organization as a whole. Affiliation with a professional lateral relation should thus have a positive effect on intraorganizational competence. Because these relations are organized by function or profession, exposure to information within the functional or professional area can also be expected to increase. In this study, the affiliation to a lateral relation occurs as a categorical variable:

Hypothesis 18: Employees affiliated with a lateral relation possess more intraorganizational competence than other employees.

Hypothesis 19: Employees affiliated with a lateral relation possess more firm-specific technical competence than other employees.

Although being cross-unit relations, these relations focus on functional or professional areas, and are accordingly expected to contribute more to firm specific technical competence than to intraorganizational competence (Proposition 3):

Hypothesis 20: The relation between affiliation with a lateral relation and the level of firm-specific technical competence is stronger than the relation between affiliation with a lateral relation and the level of intraorganizational competence.

Task forces

In addition to permanent lateral relations, *temporary task forces or project teams* are often set up in order to solve specific problems or to complete specific projects. If they are set up with people from different parts of the organization, the employees involved may be exposed to a large variety of novel information (Kanter, 1988). Assignment to cross-divisional task forces or project teams can in this way contribute to intraorganizational diffusion of knowledge (Prahalad & Hamel, 1990). Despite the current interest in these structural issues, virtually no research has examined the impact

of team participation on learning. Denison and associates (1996) measured learning outcomes (new skills, transferable skills) among product development team members and related this to the context and process of teamwork. They reported high correlations between learning and factors such as team creativity, innovativeness, importance of team for members, reward for performance and autonomy.

Beyond this, no research has focused on the effects of working on cross-unit projects or task forces. Because such task forces are cross-unit relations, participation can be assumed to increase exposure to the corporate environment (other units, colleagues and so forth). Participation in task forces can accordingly be expected to have a positive effect on introrganizational competence. Because such task forces focus on particular tasks, problems or issues, participation in a task force can also be assumed to increase exposure to information within the employees technical or professional area. Participation in task forces can then be expected to have a positive effect on the acquisition of firm-specific technical competence. In this study, I measure the number of task forces the employee has been involved in during the past two years, according to Proposition 1 I state the following hypotheses:

Hypothesis 21: The number of cross-unit task forces the employee has participated in is positively related to the employee's level of intraorganizational competence.

Hypothesis 22: The number of cross-unit task forces the employee has participated in is positively related to the employee's level of firm-specific technical competence.

As previous hypotheses relating to mobility and tenure, the effect of task force participation can be assumed to wear off as knowledge from task forces accumulates. According to Proposition 2 I expect the following:

Hypothesis 23: The relation between the number of cross-unit task forces the employee has participated in and the level of intraorganizational competence is (a) diminishing and (b) approaching zero as the number of cross-unit task forces increases.

Hypothesis 24: The relation between the number of cross-unit task forces the employee has participated in and the level of firm-specific technical competence is (a) diminishing and (b) approaching zero as the number of cross-unit task-forces increases.

Being organized around specific problems or projects (rather than function), such cross-unit task forces are generally cross-functional in nature. We can assume that task force participation increases exposure to the organizational enviroment more than it increases exposure to technical issues. In accordance with Propositon 3 the number task forces are then expected to contribute more to intraorganizational competence than to technical competence:

Hypothesis 25: The relation between the number of cross-unit task forces the employee has participated in and the level of intraorganizational competence is stronger than the relation between the number of cross-unit task forces and the level of firm-specific technical competence.

Intra-unit relations

In addition to relations spanning unit borders, various relations among employees exist within unit borders. Relations to co-workers within the unit are assumed to expose the employee to a great variety of work-related information. Two dimensions of intra-unit relations (excluding relation with supervisor) are considered: formal teams and extent of co-working.

Teams

The use of work teams is currently receiving increased attention. Empirical research indicates that the use of work teams in manufacturing has a positive effect on firm performance (Banker et al., 1996; Ichniowksi et al., 1997). Increased learning may be one among several mechanisms that account for this effect. At the team level, research has focused on group processes, individual behavior in groups and group performance (Cohen & Bailey, 1997). More recently, research on the learning dynamics of teams has emerged (Argote, 1993; Argote et al., 1995). This research is primarily concerned with

the effect of group-level (process or structural) characteristics on group performance, or individual attitudes and behavior. Others have studied individual competences for effective teamwork and how such competences are developed (Tannenbaum & Yukl, 1992).

Hudgins (1960) studied the effects of group experience on individual problem solving: no significant improvement in individual problem solving performance following group experience was found. Hudgins' results were supported by Laughlin and Barth's (1981) experiment where groups performed better than individuals, but previous effective group performance did not influence subsequent performance by individuals. These two experiments do not support the assumption that working in a team is beneficial to individual learning.

Denison et al. (1996) measured learning outcomes (new skills, transferable skills) among members of cross-functional product development teams and related this to the context and process of teamwork. Denison et al. reported high correlations between learning and factors such as team creativity, innovativeness, importance of team for members, reward for performance and autonomy. This finding suggests that team participation may have a positive effect on individual learning.

There is, however, virtually no empirical research on the effects of team participation on competences. The present study investigates the learning effect of being a team member. Teams can be assumed to increase contact with co-workers in the same unit, increase exposure to information regarding acitivities in the same unit and other idiosyncracies of the unit. Membership is thus expected to be positively related to intraunit competence. As a task-related structure, work teams are in particular expected to increase firm-specific technical competence:

Hypothesis 26: Team members possess more intraunit competence than other employees.

Hypothesis 27: Team members possess more firm-specific technical competence than other employees.

Although this measure does not capture the degree to which teams are cross-functional, I expect the effect on technical competence to be larger than the effect on intraunit competence (Proposition 3):

Hypothesis 28: The relation between team membership and the level of firm-specific technical competence is stronger than the relation between team membership and the level of intraunit competence.

Co-working

In addition to being a team member, contact with co-workers in the same unit can be achieved through cooperation that is not formally organized as a team. Co-working may occur because of the spatial structure of the work organization or because the nature of the task calls for cooperation. Learning from others may occur even if the behavior in question is not tangible or immediately observable. Working together with others may be involved in both planned training and informal learning. Although frequently regarded as one of the most important mechanisms of workplace learning, little research exists that examine the relation between co-working and competence acquisition. Teigland and Birkinshaw (1999) investigated the effects of possible sources of knowledge on individual performance. In addition to effects of experience, they found a positive relation between performance and extent of interaction with the internal community.

Two types of intra-unit collaboration are distinguished: intra-functional cooperation and cross-functional cooperation. Cooperation can be assumed to increase exposure to co-workers in the same unit, increase exposure to information regarding activities (similar as well as less related tasks) in the same unit and other idiosyncracies of the unit. Both types are thus expected to have a positive effect on the employee's intra-unit and firm-specific technical competence (Proposition 1):

Hypothesis 29: The extent of the employee's intra-functional cooperation is positively related to the employee's level of intraunit competence.

Hypothesis 30: The extent of the employee's intra-functional cooperation is positively related to the employee's level of firm-specific technical competence.

Hypothesis 31: The extent of the employee's cross-functional cooperation is positively related to the employee's level of intraunit competence.

Hypothesis 32: The extent of the employee's cross-functional cooperation is positively related to the employee's level of firm-specific technical competence.

However, because intra-functional cooperation is assumed to provide relatively more information regarding relatively similar tasks, it is expected to have a larger effect on technical competence than on intraunit competence. Similarly, cross-functional cooperation is assumed to be less task-specific and may thus have a larger effect on intraunit competence than on firm specific technical competence. Taken together, this implies the following (Proposition 3):

Hypothesis 33: The extent of the employee's intra-functional cooperation is more strongly related to the level of firm-specific technical competence than to the level of intraunit competence

Hypothesis 34: The extent of the employee's cross functional cooperation is more strongly related to the level of intra-unit competence than to the level of firm-specific technical competence.

2.3.3 COMMUNICATION

Intraorganizational mobility and organizational structures are assumed to be effective mechanisms through which employees are exposed to various intraorganizational domains. Intraorganizational communication is the transmission of written or oral information among co-workers. Whereas organizational structures, mobility and tenure are indirect measures of information exposure, communication captures the actual information transmitted.

One stream of research has focused on *organizational communication activities as an outcome*: extent of communication, mode of communication, content of communication

and networks of communication. Empirical evidence indicates that cross-unit communication results from interpersonal relationships that develop through lateral mechanisms such as joint work in teams, task forces and meetings (Ghoshal et al., 1994) and from task characteristics such as task variability, and work flow between units and dependence on other units (Van de Ven & Ferry, 1980). Hinds and Kiesler (1995) found that technical employees tended to communicate laterally whereas administrative employees tended to engage in vertical communication, lateral communication networks then serve as "shadow matrices." Recent research on organizational communication has focused on communication media, notably computerized communication technologies. This research has either been concerned with consequences of new technologies on organizational structures and behavior (e.g., Fulk & DeScantis, 1995) or with factors that predict employee choice of communication medium.

A small number of studies have focused on *outcomes of communication* in organizations. Snyder and Morris (1984) found that information exchange within peer group and quality of supervisor communication strong, positive relation to a number of objective organizational performance measures. In a study by O'Reilly and Roberts (1977), the extent and quality of interpersonal communication accounted for a substantial part of variation in group effectiveness. Muchinsky (1977) investigated the relationship between communication and organizational climate/job satisfaction, and found that vertical communication was positively related to all the climate/satisfaction outcomes, whereas horizontal (lateral) communication was negatively related to these outcomes.

Learning is frequently assumed to be one of the prime benefits for organizations tied into a network of other organizations (Podolny & Page, 1998). Empirical research on organizational learning (notably Argote et al., 1990; Darr et al., 1995; Epple et al., 1996) argues that transfer of knowledge among different organizations or different parts of the same organization is an important mechanism for organizational learning. However, only Darr and associates have applied measures of the actual communication activities. Similarly Szulanski (1996) found that the major barriers to intra-firm diffusion of knowledge are structural and knowledge-related. Lack of a relationship between the

source of knowledge and the potential recipient of knowledge was a major impediment to the transfer of knowledge between parts of the organizations (see also Hansen, 1996, 1999). Suzuki (1997) studied the effects of intergroup communication links on the transmission of culture across intergroup boundaries. Suzuki's results suggest some effects of communication on convergence of values and beliefs across groups. Most of this research has been limited to the organizational level of analysis and has mainly focused on networks between rather than within organizations.

The most notable contribution to scientific knowledge in this area, is the vast research literature on diffusion of innovations (Rogers, 1983). An innovation is an idea, a practice or an artifact that is new to a specific actor. Diffusion occurs when an innovation is communicated to and adopted by actors. This research has typically been concerned with how diffusion is affected by characteristics of actors, communication channels, and network structures. From these studies it seems clear that early adopters of an innovation have more exposure to mass media, engage in more information seeking, have more social ties and are more cosmopolitan. Rogers reviewed more than 3,000 empirical publications, and only around ten of these were complete studies of *intraorganizational* diffusion processes. Despite the basic similarities with the present study, research on diffusion of innovations differs in two crucial ways. First, research in this tradition has typically tracked the diffusion of a *specific* item in a population of potential adopters (rather than broad measures of competence as in this study). Second, research in this tradition is generally based on very specific data on interpersonal relations or complete networks (rather than broad measures of domain-specific communication).

Research on diffusion of innovations clearly indicates that the extent of communication is related to knowledge about an innovation. Studies of networks and diffusion of innovations tells us that the individual's communication channels determine what information the individual receives. We can readily assume that this mechanism can be extended to broad measures of knowledge. Based on the above, I assume that (although not explicitly stated) previous research on learning effects of communication (Argote, 1990; Hansen, 1996) involves the same mechanism of information exposure as in the present study.

In this study, I am concerned with broad measures of domain specific knowledge, and not with specific knowledge items. Exhaustive measures of the individual's specific social relations would be of limited added value compared to general measures of domain specific communication. This study focuses on effects on the individual, not on the diffusion of knowledge in a population of individuals. That is, data on egocentric communication relations should be satisfactory. Directionality of communication emerges as the most important structural characteristics of individual communication in organizations (Ghoshal et al, 1994; Hinds & Kiesler, 1995; Muchinsky, 1977; Roberts & O'Reilly, 1974).

Suzuki (1997) added the intragroup-intergroup dimension when studying the transfer of beliefs and values across group boundaries in an international organization. Teigland and Birkinshaw (1999) distinguished between the extent of interaction with company-internal and external communities of practice, and found a positive relation between employee performance and internal interaction.

In order to distinguish between communicative exposure to unit and exposure to the larger organization this study accordingly differentiates between *communication within the unit* and *communication to other parts of the organization.*

Cross-unit communication can be assumed to increase exposure to the organization as a whole as well as to task-specific issues. I accordingly expect cross-unit communication to affect intraorganizational competence in particular. To the degree that cross-unit communication concerns task-related issues, it may also positively affect firm-specific technical competence:

Hypothesis 35: The extent of the employee's cross-unit communication is positively related to the employee's level of intraorganizational competence.

Hypothesis 36: The extent of the employee's cross-unit communication is positively related to the employee's level of firm-specific technical competence.

All cross-unit communication will to some extent be related to intraorganizational issues. Talking to colleagues in other units involves a minimum of information about

these units or these colleagues. Cross-unit communication may not necessarily be related to tasks or technical issues. Communication with colleagues may be politics, updates on organizational issues, plain gossip or other non-task-specific issues. On average we can assume that cross-unit communication increases exposure to the organizational more than it increases exposure to technical domains:

Hypothesis 37: The extent of cross-unit communication is more strongly related to the level of intraorganizational competence than to the level of firm-specific technical competence.

Because intra-unit communication can be assumed to increase exposure to all domains, I expect intra-unit communication to contribute to all competence outcomes:

Hypothesis 38: The extent of the employee's intra-unit communication is positively related to the employee's level of intraorganizational competence.

Hypothesis 39: The extent of the employee's intra-unit communication is positively related to the employee's level of intraunit competence.

Hypothesis 40: The extent of the employee's intra-unit communication is positively related to the employee's level of firm-specific technical competence.

I expect intra-unit communication to increase exposure in all domains. However, because the unit is smaller than the organization as a whole, each piece of information will contribute relatively more to intraunit than to intraorganizational and firm-specific technical competence. Intra-unit communication is expected to contribute *relatively* more to unit exposure than to corporate and technical exposure (Proposition 3). The effect is accordingly expected to be largest with regard to employee intraunit competence:

Hypothesis 41: The extent of intra-unit communication is more strongly related to intraunit competence than (a) to the level of intraorganizational competence and (b) to the level of firm-specific technical competence.

2.4 Summary of hypotheses

In the previous section I discussed how three sets of factors are assumed to operate through mechanisms of exposure to different domains and how this may gives rise to domain-specific competences. These relations are outlined in Figure 2.1. Hypotheses about empirical relationships are summarized in Table 2.2.

Table 2.1 Overview of hypotheses

		Proposition 1			*Proposition 2*	*Proposition 3*
Antecedent variables		**Outcomes**			All outcomes	All outcomes
Category	**Variable**	**Intraorg. compet. (IOC)**	**Intraunit compet. (IUC)**	**Firm-specific tech. comp. (FTC)**	**Functional form (all outcomes)**	**Differential effects[a]**
Career-related factors	Cross-unit transfers	+		+	non-linear, asymptotic	IOC > FTC
	Job transitions	+	+		----"-----	IUC > IOC
	Org. tenure	+		+	----"-----	IOC > FTC
	Unit tenure		+		----"-----	
Structures	Lateral relations	+		+		FTC > IOC
	Cross-unit task forces	+		+	non-linear, asymptotic	IOC > FTC
	Team		+	+		FTC > IUC
	Intra-functional cooperation		+	+		IUC > FTC
	Cross-functional cooperation		+	+		FTC > IUC
Communi-cation	Cross-unit communication	+		+		IOC > FTC
	Intra-unit communication	+	+	+		IUC > IOC IUC > FTC

[a]Hypotheses about differences in effects on outcome variables; e.g., IOC > IUC indicates that the antecedent variable is expected to affect intraorg. competence more than it affects intraunit competence
+ Positive relation expected
blank: No hypothesis specified

The first three columns from the left indicate expected associations between independent outcome variables. Hypotheses are specified as positive or no hypothesis (blank). The fourth column indicates additional hypotheses about the functional form of relationships. A non-linear, asymptotic functional form means that the slope is expected to be monotonically increasing at a decreasing rate and asymptotically approaching an upper bound. The last column indicates, for each independent variable, the expected difference between the independent variable's effect on different outcome variables

(differential effects). IOC > IUC, for instance, indicates that the explanatory variable is expected to have a larger impact on intraorganizational competence (IOC) than on intraunit competence (IUC).

3. RESEARCH DESIGN

In the previous chapter I outlined a set of propositions and derived hypotheses about the relations between different competences and a number of variables characterizing the employee's exposure to the organization. In order to test these hypotheses, I collected extensive data from employees in the Norwegian State Oil Company (Statoil). This chapter describes Statoil, the research design and the data collection methods chosen for this study. Chapter 4 discusses measurement and chapter 5 presents the results of the hypothesis testing.

3.1 Statoil

Den norske stats oljeselskap AS (Statoil) is the dominant oil company on the Norwegian continental shelf. The Statoil corporation is the largest retailer of petrol and other oil products in Scandinavia and a substantial supplier of natural gas to Europe. Statoil has about 18,000 employees and revenues of more than 100 billion kroner. Statoil is a vertically integrated petroleum company, incorporating exploration, production, transportation, processing and retailing as well as research and technology development related to these activities. About half of Statoil's total number of employees are affiliated with subsidiaries (non-core activities) and were not included in this study (see sampling below). Its production activities were previously concentrated on Statfjord and Gullfaks, two large oil/gas fields in the Norwegian North Sea sector. Statoil operates a large subsea pipeline system in the North Sea. These pipelines connect gas producers in the northern part of the North Sea and gas consumers in continental Europe. On the Norwegian continental shelf, Statoil's portfolio is gradually becoming dominated by natural gas and petroleum fields to the north of 62° north latitude. Troll, an enormous gas field near Bergen, contains about 60 per cent of all natural gas reserves in the Norwegian sector.

Statoil has gradually expanded its international upstream operations in recent years and is now active in more than 25 countries. More than 30% of Statoil's oil reservers are in oil fields outside Norway, including Azerbaijan, West Africa, Venezuela and Great

Britain/Ireland. Statoil owns 80 per cent of Navion, a shipping company. Statoil has an 80% ownership in a gas-based methanol plant at Tjeldbergodden as well as a 50% share of Borealis, a petrochemicals group. Downstream activities further include refineries and petrol retailing. A joint venture with Statkraft, a major power supply company, and Norsk Hydro has applied for permission to set up a natural gas fueled electrical power plant.

History

Historically, Norway had no oil production. After the 1959 discovery of an enormous gas field near Groningen in the Netherlands, oil exploration began in the British sector of the North Sea and then in 1966 in the Norwegian sector. Phillips, an American oil company, discovered the first Norwegian oil field, Ekofisk, in 1969. At this time, no Norwegian company was capable of developing and operating an offshore oil field. When the extent of the Norwegian petroleum resources became clear, the question about how to organize the State's economic interests and regulatory duties was put on the political agenda. A consensus emerged that the economic interests of the state should be managed by a state-owned oil company. This company was to both administer the State's oil field ownership and be an operative oil company. Statoil was established by the Norwegian parliament in 1972.

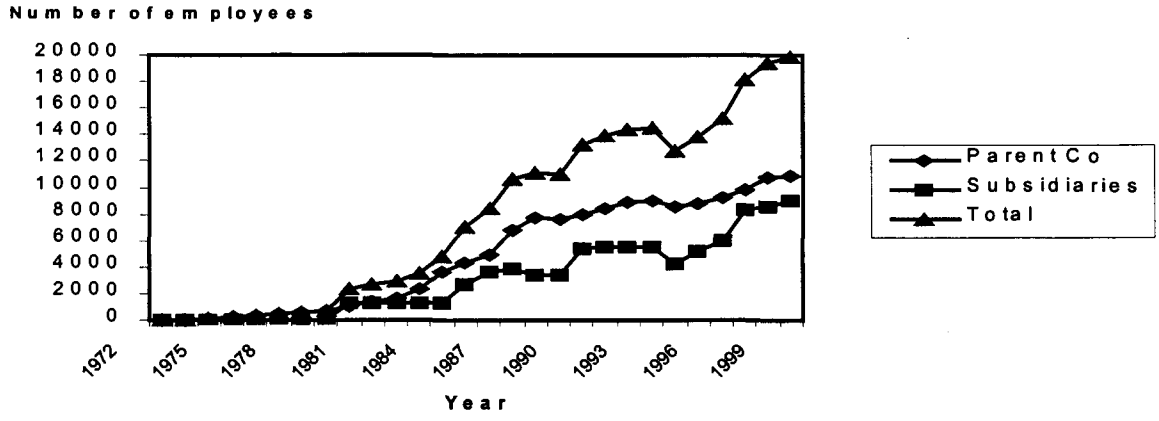

Figure 3.1: Number of employees in Statoil

Statoil's first oil field and the largest in the North Sea, Statfjord, was discovered in 1974, and production began by 1979. In this first phase of the Norwegian oil era, appropriate engineering and management competences were hardly available in Norway. Statfjord was in fact discovered, explored, developed and then operated for eight years by Mobil until the field, including 2000 employees, was transferred to Statoil. From its founding in 1972 it took only eight years for Statoil to develop the skills, knowledge and organization to be prepared to carry out both development and operation of an oil field, Gullfaks, on its own. The Statoil organization has expanded as a result of increased upstream activity in the North Sea and downstream activity on shore (see Figure 3.1). Statoil has increased its downstream engagements in terms of processing (refineries, petrochemicals and methanol), transport (shipping and subsea pipelines) and retailing (petrol stations). In addition, the company is running its own research and technology development unit.

Organization

The Statoil corporation includes the core production, processing, and transport activities, as well as refineries and natural gas based methanol production plus retail marketing (petrol stations). Statoil is a limited liability company, the Norwegian State being the sole shareowner and the stockholder's meeting consisting only of the minister of oil and energy. The corporation is managed by a board and a chief executive appointed by the board. When I collected data for this study, Statoil was organized in 15 "profit units," some of which are tightly coupled along the value chain (such as gas production or methanol), others are loosely coupled, parallel activities. There is also a technology unit (providing engineering services), an information technology unit, and a finance unit. Some profit units, such as Oil Production and Gas Production & Transport, are divisionalized in the sense that they are organized in clearly separated field units. Finally, there are corporate headquarters and staff (at Stavanger). Some business areas (mainly petrol retailing) are subsidiaries. In order to reduce the heterogenity of the sample and to ensure the relevance of research questions, only the core areas (the parent company) are included in this study.

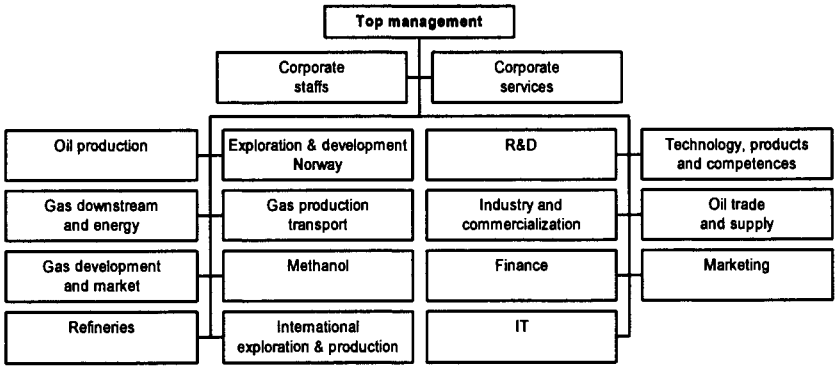

Figure 3.2: Statoil organizational chart (February 1998)

In addition to the hierarchical structure, for specific functional areas Statoil has implemented a matrix-like structure based on lateral relations involving professionals and managers in separate units. Employees within areas such petroleum engineering, exploration, drilling/wells, and personnel management are then involved in formal networking across unit boundaries. These lateral relations are in particular responsible for competence development among their members as well as transfer of personnel to units and projects. In addition, these lateral relations are responsible for technical standards and work systems as well as the use of experience to improve quality.

Offshore petroleum production in the North Atlantic

In general, there are at least three main sources of idiosyncrasies in the petroleum business. The first type is geological and concerns the prospects of finding profitable amounts of petroleum in a certain type of geological structure. It concerns the costs and technical feasibility of drilling production wells, the shape and quality of the reservoir, and may also concern the rate of production and the percentage of recoverable petroleum. Geological characteristics may be region-specific such as the Norwegian continental shelf. Exploration and production may thus require specialized knowledge. Second, there is the issue of geography that is mainly a matter of distance to end-users and distance to shore. Compared to natural gas, the costs of transporting crude oil are

less affected by distance and does not require large amounts of specific investments. Distance to shore together with the quality of production well output determine which platform and transportation solutions are feasible. The third type of idiosyncrasies stem from operating conditions such as weather (humidity, temperature), offshore vs. on-shore, and in the case of offshore operations, depth and waves. These operating conditions give rise to considerable idiosyncrasies in activities, output and factor markets, organizational design, technology and competences.

Offshore petroleum production in the North Sea and North Atlantic is a substantial challenge. The oil industry hardly had any experience with the weather conditions, waves and depth of water in this region. Wave heights in the Persian Gulf and Gulf of Mexico, even during hurricanes, do not reach the heights seen in the Northern part of the North Sea. Constructing oil platforms in 300 meter deep water, for example, is roughly 4 times as difficult as on land (Stinchcombe, 1985). Oil platforms in the North Sea are in fact among the largest man-made constructions ever. Exploring and developing petroleum fields further north and in deeper waters calls for continuous production technology innovation. Each platform will be different and each platform will be on the leading edge of offshore technology.

Summary

Statoil is a suitable context within which these hypotheses can be tested for several reasons. Statoil is a large organization with a number of geographically dispersed yet integrated units. There are a large number of specialized jobs frequently involving idiosyncratic technology and competence. The complexity of the organization itself probably places demands on the employees' intraorganizational and intraunit competence.

3.2 Research design

In order to test the propositions and hypotheses specified above, I designed a cross-sectional study. I collected data by means of a self-report questionnaire distributed to a sample of employees and I obtained data from personnel files for employees responding

to the questionnaire. A cross-sectional study measures all variables at the same time and allows for assessment of association (covariation) between variables representing presumed causes and effects. Establishing the causal (i.e., temporal) order of variables and excluding spurious relations are the two remaining challenges. In cross-sectional research, statistical control replaces experimental control for spurious relations. This means that variables representing likely alternative explanations of covariation between presumed cause and effect should also be measured. The number of potential alternative explanations is unlimited, whereas the number of variables that can be measured and analyzed is strictly limited. The choice of control variables should therefore be based on realistic assumptions about which spurious relations are most likely to occur in a particular setting.

In this study, several of the included variables represent possible spurious relations. A multivariate approach not only controls for spurious relations, but also assesses the relative impact of different variables. A cross-sectional, multivariate approach thus allows for a comparison of the importance of different antecedent variables. This research design then provides both a test of theoretical propositions and an assessment and comparison of the practical relevance of different antecedent events and conditions. Managers wanting to enhance a certain type of competence among a group of employees should alter the factors that have the greatest influence on this type of competence.

The purpose of an empirical study of this kind is to test if a particular causal mechanism can be assumed to be present, rather than to identify a set of variables that accounts for all variation in the outcome variable. In other words, the purpose is to test theoretical propositions and hypotheses; the purpose is *not* to find the set of variables that predicts the outcome with the greatest possible certainty. There is a range of other variables that could have been included in order to explain or predict employee competence. However, if these other variables are not related to the theoretical propositions, or not involved in a substantial spurious relationship with the outcome variable and one of the explanatory variables, they can be excluded without loss of information.

Data collection, measurement and sampling are described in the sections below.

3.3 Data collection

I collected data from two sources: A self-report questionnaire and personnel data files. Data from personnel files were collected both as supplements to and as a validation of self-report data.

To get access to personnel files, respondents were asked to sign a "statement of consent" authorizing the use of specified personnel data for this particular research project. Respondents had the option of completing and returning the questionnaire without signing the statement of consent; these respondents would then be completely anonymous.

Respondents who decided to sign the statement of consent, were then asked to report their (company internal) employee number. The employee number allowed efficient extraction of personnel data from Statoil's personnel database. Identification of employees by number only guaranteed employees some degree of anonymity; respondent name can only be found in the signature on the statement of consent itself. The statement of consent was immediately separated from the self-report questionnaire. When data from the self-report questionnaire and from personnel files were completely merged, employee numbers were erased from my data file.

The outcome variables in this study, competences, were collected through self-reports only. No archival data could serve as substitutes for self-report data. Respondent self-rating of knowledge and skills does, however, raise specific validity questions (Ashford, 1989; Mabe & West, 1982). Mabe and West's meta-analysis indicates that several measurement conditions affect the accuracy of self-assessments, and they suggest that these conditions may be altered in order to increase accuracy of self-report. First, the use of social comparison terminology, such as "better than average" or "as compared to your fellow workers", in the questionnaire improved the validity of the self-rating. Second, respondents that were likely to expect validation of their self-reports delivered more accurate answers as compared to a criterion measure. Third, promises of anonymity are believed to have some effect on self-report accuracy.

In this study, I used a comparison terminology in a few questionnaire items (see measurement details in chapter 5). Respondents who signed the statement of consent were requested to authorize a third person's (supervisor's) rating of their competences. Even if this option was not used as a validation of self-ratings, respondent expectation of a validation may have motivated more accurate questionnaire responses. Respondents were, however, promised subsequent anonymity; there should consequently be no motivation for self-enhancement.

Factual data were collected in two different ways: Respondents were asked to provide information about organizational affiliation, tenure, type of job, content of job, age, gender and education on a separate sheet in the questionnaire; and similar data were extracted from the company personnel data base for the respondents that had signed the statement of consent only. Self-report data contained between 2% and 10% item non-response. For most cases, missing information was found in the personnel database. This approach provided both a validity check of self-reports and a supplement for cases with missing self-report data. For example, if self-reported education did not correspond to the personnel file data, questionnaires were reexamined for possible coding errors or misunderstanding on the part of the respondent. Archival data were used to replace missing data on education, current job and career history.

TABLE 3.1 Data

Source	*Type*	*Issue*	*Instrument*
Personnel files	Factual	Organizational affiliations Current job Career history Education Internal training	
Respondent (self-rating)	Judgmental	Competence Communication	Specifically designed Adapted
	Factual	Structure/affiliations Current job Transfers/transitions/tenure Gender, age, education	

3.4 Sample and sampling procedure

As discussed above, the core activities of Statoil (i.e. excluding subsidiaries and joint ventures) provided an appropriate setting for empirical investigation. Statoil granted access to company files and supported a company-wide survey.

I tried to design a sample that ensured relative heterogenity with regard to variables in the model and relative homogeneity with regard to other variables, while maintaining relevance with regard to large groups of employees. The pilot study revealed substantial differences with regard to the outcome variable within categories of employees. Intraorganizational competence, for instance, is more relevant to managers than to blue-collar workers. The extent and variation of cross-unit communication, cooperation and formal cross-unit structures are also fairly modest within this group compared to managerial and professional employees. Major differences in job content and characteristics further increase the heterogeneity among these groups.

I consequently decided to limit sampling to employees in managerial and professional jobs, both defined by the characteristics of the jobs rather than by characteristics of the job incumbents. This strategy produced a sampling frame with sufficient heterogeneity with regard to the variables of interest.

I compiled the sampling frame from a complete list of employees (identified by employee number only), their respective job titles and affiliation to a lateral structure. Jobs such as project manager, department head, production manager, oilrig manager and personnel manager were classified as *managerial jobs*. Senior economist, engineer, geologist, personnel advisor, senior market analyst and lawyer are examples of what I classified as *professional jobs*. All other jobs were defined as service or blue-collar work, such as clerks, cooks, platform deck workers, receptionists, drivers, production process operators and technicians. This procedure produced a sampling frame of 1539 managers and 4,333 professionals from a total of 9,550 Statoil employees in core activities. (About half of Statoil's 18,000 employees are employed in subsidiaries and were not included in the sampling frame.)

TABLE 3.2: Stratification of sampling frame

"Network " (Type of lateral relation)	Type of job		
	Manager	Professional	Total
No affiliation	735	1722	2457
Administrative	428	1231	1659
Engineering	376	1380	1756
Total	1539	4333	5872

Based on data from personnel files, managers and professionals were then classified according to their affiliation to a permanent lateral structure (called "networks"): no affiliation, engineering networks and administrative networks. This produced six strata, as shown in Table 3.2. From each stratum, a 50% random sample was drawn. A file containing the selected employees (identified by employee number) was handed over to a personnel files manager at Statoil who then produced a mailing list based on the employee numbers.

4. MEASUREMENT

This chapter first describes how the questionnaire was constructed and tested, and thereafter discusses the operationalization of each variable. In the third section the questionnaire layout is described and then the measurements based on archival data are described. Questionnaire response, measurement assessment and finally variable constructions are reported in the last three sections.

4.1 Operationalizations: Self-report data

I collected self-report data for three groups of variables: Outcome variables, control variables (not shown in the research model) and explanatory variables. Some variables in each group refer to organizational unit (intraunit competence, intra-unit communication). In the context of this study, the employee's organizational unit was defined as the Statoil business area (for the smaller areas) or the profit unit (within the three largest business areas - Oil production, Natural gas, and Competence and technology services) in which she or he is currently employed.

4.1.1 OUTCOME VARIABLES

Measures applied in previous research

Empirical research on the firm-specificity of competence is typically concerned with the degree or amount of investments in firm-specific competences among employees and relates this to organizational and contractual properties. Typical measures of firm-specific training at the job-level are the number of hours of training received by a typical job incumbent after hiring (Davis-Blake & Uzzi, 1993), the degree to which the employer provided on-the-job training (Cohen & Pfeffer, 1986), average within-establishment training and experience required for its jobs (Baron, et al., 1986), and the weeks and months of training (excluding education) required to do a particular job (Kalleberg & Reve, 1993). Although adequate measures of the learning *required* or training *provided* by the employer, these measures are not appropriate as measures of the outcome variables in the present study for two reasons. First, these measures do not

distinguish between at least two different types of firm-specific competence: intraorganizational competence and firm-specific technical competence. Second, these measures are all at the job-level or firm-level, not at the level of the individual employee. These measures capture a firm's general or job-specific training policy, or perceived competence requirements of specific jobs or all jobs in the firm.

The outcome variables based on Nordhaug's typology (1993) have as such not been operationalized for self-report survey data collection. Motowidlo and associates (1997) distinguished between task and contextual competences that govern task and contextual performance, but do not suggest a framework for measurement. A small number of measures of, for example, job learning (Morrison & Brantner, 1992), task proficiency/mastery (Lance et al., 1989), job knowledge and performance (McDaniel et al., 1988), technical competence (Kirchner, 1965), and knowledge about specific features of the organization (Williams & Levy, 1992) have been elaborated.

Objective measures of competence have been used within highly specific professional fields (Tubbs, 1992), in experimental research on consumer decision-making (Coupey & Narayanan, 1996) and in polls measuring the prevalence of specific knowledge in the general population, for example knowledge about leading politicians or knowledge about specific brands and products (Sudman & Bradburn, 1982). Measures of task performance are usually job-specific whereas measures of non-technical performance include general social skills as well as highly specific aspects of performance (e.g., proper military courtesy) (Motowidlo & Scotter, 1994). However, either these do not fit the work-related competences included in this study or they can not be applied across different jobs.

There are only a small number of empirical investigations that measure variables similar to those in the present typology. Campion et al. (1994) developed a broad list of competence needs within the finance function of a company and (based on factor analysis) grouped these into three competence types: administrative, technical and business. Administrative competences cover a range of general competences, technical competences are related to accounting and finance (i.e., standard technical competences) whereas business competences roughly correspond to intraorganizational and industry

competences. These measures are not relevant, being too specific or too broad for the purpose of this study.

Sonntag and Schäfer-Rauser (1993) distinguish between methodical competence (creativity, ability to learn, problem solving), social competence (communication, cooperation), and technical competence (task-related skills and knowledge). The former two are examples of general competences, whereas the latter corresponds to various types of task specific competences. Technical competence was further split into skill (task proficiency) and knowledge. Knowledge items included for example "I know very well how technical equipment needed in my field of practice works" and "I know the best way of doing most of the work that I am assigned to."

Arnold and Davey (1992) operationalized company know-how, interpersonal skills, product knowledge, specialist competence and skills in achieving results; these constructs clearly resemble those in the present typology. Some of Arnold and Davey's constructs (as operationalized) do overlap those of Nordhaug's typology. Product knowledge, for example, includes both knowledge about the company's products (intraorganizational knowledge) and knowledge about products of competitor companies (industry knowledge). Similar operationalizations are used in research on consumer product knowledge (Brucks, 1985).

Kozlowski and Farr (1988) collected data on competence and competence maintenance (updating) among engineers. Based on factor analysis results they distinguished among competence maintenance activities, general technical competence and general administrative skills. General technical competence included possession of fundamental engineering knowledge, ability to understand causes of a problem, ability to create several feasible solutions to a problem, and ability to evaluate alternative solutions. General administrative skills included ability to communicate, ability to seek others for help and advice, ability to plan and organize, ability to implement solutions in a specific situation, and response to change. Kozlowski and Farr did not distinguish firm specific and firm non-specific components.

Current measures

I considered two strategies for the operationalization of variables in this study.

(1) A measure of overall domain knowledge could be elaborated.

(A) A measure of the amount of experience required to reach this particular employee's level of knowledge could be constructed, for example "Imagine a person having about the same education as you and your experience, but from a different oil company. How much time would this person need to gain your level of knowledge about the Statoil organization?" Such a measure will easily be contaminated both by the requirements of the job and by the person's speed of learning. One could risk that a slow learner would report extensive knowledge about the particular issue. Such an operationalization could possibly produce data at a high level of reliability, whereas the concept validity could be seriously questioned.

(B) Alternatively, a global measure of the employee's self-assessed level of domain-specific knowledge could be constructed. Careful wording would, however, be required to specify the domain. This strategy would in fact require that I communicate my conceptual framework to the respondents. A large proportion of respondents could be confused or exhausted by cumbersome delimitations of domains. Respondents that grasped the full meaning of such questions, would face a challenging task trying to judge for example their own intraorganizational competence (Sudman & Bradburn, 1982). In addition to a loss of reliability, concept validity would be at risk.

(2) A multi-item measure could be constructed by sampling domain-specific objects. The employee would then be asked to assess his or her degree of knowledge about these objects. Intraorganizational knowledge, for example, is measured with items such as "I am well informed about the activities of other Statoil units" and "Compared to my fellow workers, I have extensive knowledge about Statoil's organizational structure." By asking clear and short questions about relatively specific issues the likelihood of misinterpretation is reduced. The relation between individual items and theoretical variables can be evaluated fairly easily in order to establish concept validity. Each

respondent's self-rated competence with regard to a sample of objects within a domain should then be summarized into an index of competence with regard to the domain as a whole. It is virtually impossible to construct an exhaustive list of objects within a domain, nor is it possible to obtain a representative sample of objects. I do however believe that it is possible (guided by theory, pilot studies and sound judgement) to suggest a varied selection of important issues within a domain. In addition, random measurement errors in individual item ratings will to some extent even out across multiple items. This strategy should accordingly provide acceptable reliability and validity.

I chose the latter strategy for this study. I then used a small number of relevant questionnaire items from the above studies (Arnold & Davey, 1992; Campion et al., 1994; Kozlowski & Farr, 1988; Sonntag & Schäfer-Rauser, 1993) as patterns for items in the present study and constructed items from a list of domain-specific objects (see Tables 4.1-4.3). Note that the questionnaire items constructed this way should not be regarded as reflective measures of an unobservable individual trait. Competence items with regard to domain-specific objects together constitute the respondent's total competence in that domain.

Table 4.1: Intraorganizational competence

Item #	Item wording
231	I am well informed about the activities of other Statoil units.
232	Compared to most of my colleagues, I have a good grasp of Statoil's organizational structure.
234	I have a good command of the routines in Statoil.
235	Compared to most of my colleagues, I know how to influence important decisions in Statoil.
236	I have extensive knowledge of Statoil's strategy, objectives and history.
237	I know who to ask for help within Statoil to solve problems that might occur.

Ratings: 1 (strongly disagree) to 5 (strongly agree)

Table 4.2: Intraunit competence

Item #	Item wording
241	I am well informed about the activities of other departments in my unit.
242	Compared to most of my colleagues, I have an extensive knowledge of the structure of my unit.
243	I have a good command of the routines in my unit.
244	Compared to my colleagues, I know how to influence important decisions in my unit.
245	I have extensive knowledge of my unit's strategy, objectives and history.
246	I know who to ask for help within my unit to solve problems that might occur.

Table 4.3: Firm-specific technical competence

Item #	Item wording
271	Compared to my colleagues, I know very well how similar tasks are performed in other Statoil units.
272	I have somewhat inadequate knowledge of circumstances specific to Statoil.
273	I have somewhat inadequate knowledge of how to use Statoil-specific equipment.
274	I have good command of working methods within my field in Statoil.
275	I am well aware of current developments within my field within Statoil.
276	Compared to most of my colleagues, I have extensive knowledge of Statoil's main challenges within my field.
277	Compared to my colleagues, my knowledge of Statoil's experiences within my field is good.
278	I have extensive knowledge of Statoil's standards within my professional field.

4.1.2 EXPLANATORY VARIABLES

This study includes three groups of explanatory variables: career-related factors, structural factors and communication.

Career-related factors

This set of explanatory variables concerns the career history of the individual within the organization. Campion et al. (1994) obtained printed records of employees' career history in order to measure this type of variables. In the present study, access to individual personnel records was not granted in advance. I consequently collected career-related factors both in the self-report survey (all respondents) and from personnel records (non-anonymous respondents). Two types of career-related factors were measured: duration of employment in Statoil and the current unit, and the total number

of job changes within the company (see also Louis, 1980; Pinder & Walter, 1984). These variables are factual and are measured with one question each (see Table 4.4 for wording). First, employees reported the length of their tenure in Statoil, in the business area and in the profit unit on the "background data" sheet of the questionnaire. Second, employees reported the number of different within-company jobs held, and the number of transfers between profit units and business areas.

Table 4.4: Career-related factors

Item #	Question wording	Response
301	How many years of work experience do you have within Statoil?	years
311	How many times have you changed job in Statoil?	(number)
312	How many of these were across divisional borders (or what corresponds to current divisonal borders), across corporate staff borders or across staff-division borders?	(number)
313	How many of these were across profit unit borders (alternatively corresponding to current profit units)?	(number)
314	How many years have you been with your current business area (or equivalent) or corporate staff?	years
315	How many years have you been with your current profit unit (or equivalent)?	years

Structural factors

This set of factors concern the employee's formal relations within the unit and across units. First, I measured intra-unit relations in terms of the individual's involvement in teams and the extent of intra-unit cooperation. Each respondent reported the number of work groups in which he or she was involved at the time, and then reported the number of hours a day that she or he worked together with others (Roberts & O'Reilly, 1974). Number of hours a day was separated into two questionnaire items, one regarding the number of hours spent working together with co-workers with tasks different from the employee's own and the other regarding time spent with co-workers having similar tasks. I designed these items specifically for this study in order to measure the extent of cross-functional and intra-functional cooperation, respectively. Although basically a factual question, some memory retrieval and judgement are required to estimate the hours of coworking during a normal day.

Second, I measured two types of cross-unit relations. Respondents reported their affiliation with a formalized lateral network of professionals. Such lateral relations have

been established in Statoil in order to integrate professionals who are dispersed among several units. Each network is dedicated to one functional specialty or professional field such as finance, subsea technology or platforms. This measure captures cross-unit and functional exposure through formal structures. Being a clearly factual measure based on organization-specific terminology, respondents should not have any problems answering this question and no validity problems should arise. In addition, respondents reported the number of cross-unit task forces they had been involved in during the past two years. This was intended to measure cross-functional and cross-unit exposure through formal structures (Ghoshal et al., 1994). Although basically a factual issue, the question was not based on common terminology in Statoil and may not have been entirely clear to all respondents.

Table 4.5: Structural factors

Item #	Question wording	response
011	In which business area or in which corporate staff are you currently employed?	(open)
012	In which profit unit are you currently employed?	(open)
411	How many work groups are you currently involved in?	(open)
421	How many cross-unit task forces or project groups have you been involved in during the last two years?	(open)
441	Which functional lateral relation are you affiliated with (if any)?	(open)
541	During a normal day at work, how much time do you spend working together with others who perform *similar* tasks?	never - more than 6 hours
542	During a normal day at work, how much time do you spend working together with others with tasks *different* from your own?	never - more than 6 hours

Communication

This set of factors concerns the extent of employee's communication activities *within the unit* (intra-unit) and *across unit borders* (cross-unit). Previous research has applied various operationalizations of organizational communication. Roberts and O'Reilly (1974) developed separate measures for mode of communication (written, face-to-face, telephone) and directionality of communication (upward, lateral, downward). Van de Ven and Ferry (1980) used time ranges of 3 months for both intra-unit and cross-unit communication, and provided five response categories ranging from "about every hour" to "not once". Tushman and Scanlan (1981) collected data on technical communication once a week for five weeks. Eisenberg et al. (1983) collected data about job-related

communication between specified employees within the organization. For each named employee, respondents were asked to estimate how many hours they spent communicating with that person during a typical week at work. In their study of cross-unit communication, Ghoshal et al. (1994) asked respondents to indicate the *typical* frequency of their communication with other units on a scale from daily to less than annually, as well as the number of days per year in cross unit meetings. In their study of communication across unit boundaries, Hinds and Kiesler (1995) gathered data through a 48-hour diary of all communication. Respondents were instructed to log data for each instance of communication (mode, name of sender/receiver, content) over two days.

For the purpose of this study, communication should ideally be measured as the total amount of each type of communication during the individual's time within the organization. Measures of actual behavior should be concrete and specific, and time ranges should be designed both to make memory retrieval easy and to capture relatively infrequent behavior (Sudman & Bradburn, 1982). Measures should be designed to minimize effort and need for estimations on the part of the respondent. It is practically impossible for the individual to recall or reconstruct the extent and pattern of communication five or ten years ago. Thus, communication must be measured for a relatively *recent period of time* and this period must be assumed to be typical or representative for the employee. In addition, very short time ranges are more liable to random fluctuations than longer periods.

The extent of communication can be measured as the percentage of time spent in contact with categories of other employees (Roberts & O'Reilly, 1974), the time spent communicating during a specified period of time (Eisenberg et al., 1983), or the frequency of specific instances of communication (Van de Ven & Ferry, 1980; Ghoshal et al., 1994). For written communication and for informal oral communication, time spent communicating is probably more difficult to recall or estimate than frequency of such communication. Extent of communication is more easily measured as the *frequency* of a particular communication behavior.

When measures are relatively specific, multiple items are needed to capture overall communication. Items should be constructed by sampling communication issues that

cover the variety of actual communication in the organization (Van de Ven & Ferry, 1980). Items should thus be as heterogeneous as possible with regard to type and content of communication. Frequent communication requires short time ranges to make estimates of frequency easy, whereas relatively infrequent communication requires longer time ranges in order to capture variations in infrequent communication.

Based on the above, I decided to measure the extent of communication as the *frequency of specific instances of communication during a relatively recent period of time.* Intra-unit and cross-unit communication were measured using items identical except for the words "same unit"/"other unit" and the time range (see Tables 4.6 and 4.7). I selected and adapted six different communication issues from Van de Ven and Ferry (1980; see also Ghoshal et al., 1994, Roberts & O'Reilly, 1974): professional exchanges, discussions related to specific tasks, requests for help or advice, receipt of reports and memos, getting help or advice from co-workers, and participation in meetings with more than two people. The first item for intraunit communication read "During the past week, how often did you have professional exchanges with individuals in your own unit?" For cross-unit communication I set the time range to "past 3 months" to capture less frequent communication. For each item, I provided six response categories ranging from "never" (all items) to "at least every hour" (intra-unit items) and to "at least every day" (cross-unit items). For each response category, I assigned values from 1 (never) to 6 (most frequent).

Table 4.6: Inter-unit communication

Item #	Item wording	Response categories[a]
511	During the past 3 months, how often did you have professional exchanges with colleagues in other organizational units?	never - at least every day
512	How often have you and colleagues in other units discussed tasks during the past 3 months?	never - at least every day
513	How often did colleagues in other units ask for your help or advice during the past 3 months?	never - at least every day
514	How often did you receive reports or memos from co-workers in other units during the past 3 months?	never - at least every day
515	How often did you receive help or advice from co-workers in other units during the past 3 months?	never - at least every day
516	During the past 3 months, how often did you participate in problem-solving meetings involving 2 or more co-workers from other units?	never - at least every day

[a]Coded 1 (never) to 6 (at least every day)

Table 4.7: Intra-unit communication

Item #	Item wording	Response categories[a]
531	During the past week, how often did you have professional exchanges with individuals in your own unit?	never - at least every hour
532	How often did you and colleagues in your own unit discuss tasks during the past week?	never - at least every hour
533	How often did colleagues in your own unit ask for your help or advice during the past week?	never - at least every hour
534	How often during the past 3 months did you receive written reports or memos from co-workers in your own unit?	never - at least every day
535	How often during the last week did you receive help or advice from co-workers in your own unit?	never - at least every hour
536	How often did you participate in problem-solving meetings involving 2 or more co-workers from your own unit during the past 3 months?	never - at least every hour

[a]Coded 1 (never) to 6 (at least every hour/day)

4.2 Questionnaire pretesting

I administered a preliminary questionnaire to a pretest sample, a heterogeneous group of 25 employees taking part in an internal training program in Statoil. In addition, I consulted a few employees for an in-depth discussion of particular issues. This pretesting revealed a number of problems.

Several pretest respondents considered the words "trade", "profession" or "occupation" ("fag") as imprecise or ambiguous. In the refined questionnaire I therefore decided to define occupation or profession as the employees *current field of practice*, giving educational background less weight. In the questionnaire, I instructed managerial employees to define their occupational affiliation as the one most characteristic of the activities of the group of employees that they were currently managing.

The total number of items on the preliminary questionnaire and the number of related or similar items appeared to be too large. I consequently simplified the questionnaire as follows. The number of questions on factual issues was reduced to a minimum. Moreover, items with minimal variation across employees were removed.

The pretest questionnaire was organized by variable and groups of variables, which left respondents exhausted by long sections of highly similar items. I reorganized the final questionnaire according to the object to which questions refered. Questions regarding for example intra-unit competence and behavior were grouped into a separate section. In this way, concepts such as "organizational unit" or "current field of practice" could be defined and used in a more precise way, and questions would appear less monotonous and more varied.

4.3 Questionnaire organization and layout

To avoid questionnaire and item non-response, I made an effort to keep the questionnaire as short and readable as possible. I reorganized items into sections according to the object or entity (for example job or unit) to which they referred, instead of according to the group of theoretical variables they belonged (e.g., communication). This simplified the explanation of concepts such as "unit" and "occupation/profession/field of practice" ("fag") to respondents. It also made the question format more varied and less tiring for the respondent.

Computerized scanning turned out to be the most efficient data entry method for a large sample. Scanning is, however, most appropriate for closed-ended questions. Accordingly, I placed open-ended questions on the first page of the questionnaire. Opinion A/S, a market research institute, designed and printed the closed-ended sections of the questionnaire.

As shown in Appendix A, the final questionnaire contains five sections:

1. Background information
2. About the organizational unit
3. About the Statoil organization as a whole
4. About your field of practice (profession, occupation)
5. About your job in Statoil

4.4 Questionnaire Response

I distributed a total of 2,922 questionnaires. In addition to my own cover letter, I attached a letter of recommendation from Statoil's vice president of human resources. All questionnaires were mailed from Statoil's Bergen office on January 28-29 1998. Letters reached the majority of addressees on the same day or during the following two days. A response deadline on February 10 was indicated on the cover letter and on the first page of the questionnaire, and a targeted reminder by e-mail was delivered on 4 February. I received the first completed questionnaires January 30 and 740 responses were received within the indicated deadline. My own phone number, fax number and e-mail address were printed on the cover letter, and respondents were encouraged to contact me if they had any questions or comments.

Several respondents phoned and asked questions about particular items or about my sampling procedure and to post comments about limitations in my approach. "I need some advice in order to answer questions as accurately as possible so that you get the best possible results from your survey" one respondent commented. Another employee said, "I am on leave, so my answers may distort your data". Several respondents expressed concern about the exactness of their responses. Some indicated that questions were so detailed that an accurate answer was difficult to provide or that items were too similar to make a difference. Several respondents phoned me to make sure that, even if their response was overdue, their answers would be included in the data set.

In order to increase response rates, I attached a letter of recommendation from Statoil's vice president of human resources to the cover letter and an e-mail reminder to the total sample was distributed. A total of 981 employees (34% of the sample) returned a completed questionnaire. Low salience of topics and no advance notice (Roth & BeVier, 1998) may, in addition to frequent internal surveys among all employees, explain the relatively low response rate. One of the employees that actually responded to the questionnaire stated that "I do not see the point in these surveys". Others commented that "numerous surveys within the company have not produced any results for the employees" or "issues in this survey are not that relevant, do not address the fundamental problems in the company".

I divided the data collection into two parts: A self-report, mail questionnaire and archival data. In order to get access to archives, I asked respondents to sign a "statement of consent". 89% of the respondents who returned a completed questionnaire signed this statement (see Table 4.8). It seems that some employees may have felt uneasy about the thought of authorizing release of their personnel files to a complete stranger. Some respondents commented that "I am confused about the purpose of this part of the study, and therefore considered not responding to the questionnaire" or "I do not trust the guarantees given in the cover letter and statement of consent, but I am willing to take the risk". This may have affected the response rate. The response rate was probably strongly affected by the length of the questionnaire. Some respondents complained that it is "a comprehensive and cumbersome questionnaire requesting more time than I can spare".

TABLE 4.8 Survey response

	N	*%*
Statoil employees (excl. subsidiaries)	9550	
Sampling frame	5872	
Sample	2936	50% of frame
No longer employed	38	
Purged sample	2898	
Returned, not completed questionnaires	5	
Completed questionnaires	981	34% of sample
Signed "statement of consent"	873	89% of responses

Response rates of different sampling strata for the non-anonymous group of respondents are shown in Table 4.9. Response rates do not differ significantly across strata.

TABLE 4.9 Response rate by strata, non-anonymous respondents

		Type of Job		
		Managers	Professionals	Total
"Network"	No affiliation	29.9 %	29.0 %	29.3 %
(Type of	Administrative	29.4 %	29.4 %	29.4 %
lateral relation)	Engineering	29.8 %	28.4 %	28.7 %
	Total	29.7 %	28.9 %	29.2 %

Chi-square test for equality of response rates: Chi-sq (df=5) = 0.25 (p = 0.998)

N=856

TABLE 4.10 Respondent characteristics

	Mean	*St.dev.*	*%*
Age	43.8	8.8	
Years of education[a]	6.8	1.9	
Tenure (years)	11.6	5.5	
Female			18.1
Male			81.9

[a]After primary school N=964

Table 4.10 presents selected respondent characteristics. Note that the average tenure is more than 11 years (Statoil recently celebrated its 25th anniversary). On average, respondents have completed about 4 years of college or university education. Table 4.11 reveals that more than half of the respondents have engineering or natural science training. Less than 15 percent never went to college or university, and less than 1 percent do not have any secondary education. The sampling frame included 23% women and 77% men. Males had a somewhat higher response rate than females (significant at 0.002 based on Z-test for a proportion).

TABLE 4.11: Respondents by type of education

Education	*N*	*%*
Graduate Engineer (M.Sc. or equivalent)	255	27.1
Engineer (college graduate)	192	20.4
Vocational education	107	11.4
Business degree	101	10.7
College graduate	76	8.0
M.Sc. (natural sciences)	71	7.5
Doctoral degree	38	4.0
Undergraduate	25	2.7
other	76	8.1
Total	941	100.0

4.5 Item response

There are two kinds of responses to individual questionnaire items: Responses according to the given response scales and comments written on the questionnaire sheets

or received by e-mail or phone during data collection. In this section I will discuss non-responses as well as comments from respondents.

There is an average non-response of 1.8 % across items (response statistics for all items are reproduced in the Appendix B). A number of factual questions have a significantly lower non-response than the average. For gender, unit, type of job, content of job, organizational tenure, unit tenure and job transitions there are virtually no missing data. This indicates that questions were well understood by respondents and that respondents have not been reluctant to answer. For questions about participation in teams (item 411) and task forces (421) there are, however, more than 5% missing data. These questions are on the first page of the questionnaire and do not involve sensitive issues. This indicates that these questions were not well understood by respondents. The response rates for judgmental measures are generally close to the average. However, one measure of competence involving comparison with co-workers has a below average response rate. It appears that many employees perceived comparison with colleagues as threatening or sensitive questions.

A number of respondents expressed concern about the validity or appropriateness of the questions aimed at comparing themselves with "most of their colleagues" or "a typical colleague" (see for example item # 242, 254). There seems to be at least three reasons for this. First, due to lack of knowledge about colleagues' competence, some respondents found it difficult to respond to such items. Second, other respondents considered such questions as inappropriate on moral grounds, arguing for example that it would be "self-centered to emphasize oneself at the expense of ones colleagues" or that it would be "egocentric to rate oneself higher than ones colleagues". One respondent commented that "the question is a provocation, why inflate myself?" Third, a few respondents could not compare because they were the only employees with a particular kind of job, for example "my job is in a highly specialized field, there are no comparable jobs within Statoil".

Other comments pointed out that questions concerning communication and cooperation are "very demanding to memory". Some respondents commented that notions of profession, occupation or field of practice (fag) "does not fit our reality because we have

changed tasks and jobs frequently" or "is vague in the case of the tasks in my job" or "what is a profession or field of practice?" or "I do not work within a specific field of practice". In particular, some questioned the notion of profession or field of practice for managerial jobs. Expert judgements and pretesting had identified this problem, and the questionnaire thus provided a very precise description of how "occupation" should be interpreted.

4.6 Measurement assessment

Variables in the present study are factual or judgmental. Accordingly, the quality of measurement both depends on how well questions are understood by respondents and on respondent knowledge or memory with regard to a particular issue. Even if there is only one right answer to a particular question, the respondent may have problems recalling a number or a name. In addition, some questions, notably questions about task forces and teams, appears to suffer from inadequate precision, and inflated random error may result.

Respondents were further asked to indicate the number of job changes (item #311) during their time at Statoil, and how many of these were transfers between units (items 312 and 313). I feared that these questions could cause some confusion due to a number of reorganizations during the past 10 years. Several reorganizations caused nominal job changes that on closer inspection appeared as no real change in tasks and work environment. This certainly affects conclusions about the actual frequency of job changes among employees. If the ratio of real to nominal job changes is constant for this specific sample of employees, conclusions about correlations are *not* affected (unstandardized regression coefficients will of course refer to nominal job changes). Vagaries of these measures may have contributed to some increases in random error. However, a small subsample inspection indicates that most respondents have included only real and not nominal job changes. I assume that these measures are adequate and that no substantial biases in correlations are introduced.

After the data collection was completed, I realized that the number of job transitions *in the current unit* cannot be precisely calculated based on the raw data described above.

Only the total number of job changes (excluding transfers) within Statoil can be calculated. Employees who have worked with several units may also have changed jobs within several units. Thus, for employees with a large number of transfers and a large number of non-transfer job transitions, I can not determine within which unit non-transfer job transitions occurred. Although a most unfortunate error, it does not appear to affect the results presented below: About 360 respondents never transfered. Separate regression analyses with regard to competence outcomes (chapter 5) within this subsample produced virtually the same results as the analyses based on the full sample. This issue is discussed in greated detail in Chapter 5.

About 360 of the 981 employees in this study had never been transferred between units. For those employees that never transfered between units, all job transitions occurred within the unit, and I should, according to the above, have obtained a more precise measure of intra-unit job changes. For those who never transferred, correlation between intra-unit job changes and intraorganizational competence is 0.13 and the correlation between intra-unit job changes and intraunit competence is 0.23. For those who transferred at least once, these correlations are 0.14 and 0.11, respectively. The differences between correlations with intraunit competence indicate that there are less random disturbances, job changes for instance more accurately measures the actual number of job changes in *current* unit.

Questions concerning communication activities during a specified period of time and cooperation during a typical day at work are essentially factual, but may require calculation, guessing or imagination on the part of the respondent. These questions were hence labeled "judgmental". Self-reporting on competences involves additional uncertainties.

Communication both within and across units may take many forms. Each instance of communication should then add to a measure of the employee's total communication activities. Different forms of communication may further be regarded as functional substitutes, one can for example use e-mail instead of telephone. I consequently maintain that a set of items for intra-unit and cross-unit communication are formative rather than reflective measures. Accordingly, traditional concerns for inter-item

reliability and convergent/discriminant validity are not relevant. An exploratory factor analysis did, however, reveal that items measuring intra-unit communication are more related with each other than with items measuring cross-unit communication (and vice versa) (see Appendix C for detailed factor analysis results). This indicates that employees who communicate extensively within the unit, tend to use a variety of communication channels, formats or media. The observed factor pattern suggests that the direction of communication rather than communication media choice is the most important characteristic of individuals' communication. Low non-response rates and only a few written comments indicate that the questionnaire items were well understood by the respondents. Memory and estimation requirements involved in these items may have affected the accuracy of responses.

In principle, the same applies to competence measures. Different questionnaire items are intended to measure different domain specific pieces of competence that together constitute the competence in that domain. There is no reason to assume a priori that, for example, "knowledge about other organizational units" (item 231) and "knowledge about organizational routines" (item 234) should be correlated or should reflect the same one-dimensional, latent variable. What we can assume, is that these items concern the same domain. In an exploratory factor analysis, items clustered according to three competences variables with two important exceptions. Items requesting an explicit comparison with co-workers and reversed items load on two distinct factors. This may result from response sets or careless responding. By removing these items from the overall measures, we may inflate correlations.

As previously mentioned, several respondents reported discomfort about rating their own competence compared with their co-workers. Reactions to the comparison format questions are somewhat surprising given the positive findings for this format in North-American studies (Mabe & West, 1982). If an employee does not have adequate information about the colleagues' competence, ratings involving comparison may be unreliable. However, self-rating on scale must in any case involve an implicit baseline with which comparisons are made. The second reason may possibly be related to egalitarian norms. Measures involving comparison may be both more acceptable and valid in a context of competitive and individualistic norms, such as in the USA, than in

a context of egalitarian norms and relatively less individualism, such as in Norway (Hofstede, 1980). However, missing data appear to be the worst consequence for these items.

4.7 Archival data: Operationalization and assessment

The archival data are useful in three different ways. First, a number of respondents did not provide complete information about their type of job, name of unit or educational background. In these cases, archival data complemented the data set. Second, a number of variables were extracted from the database for all non-anonymous respondents: Job title, location, employment terms (regular vs. temporary), working hours per week, offshore vs. onshore, within company (internal) work history, external work history, lateral relations history and history of training provided by company.

"History" variables were operationalized as *the number of lines of information in the individual's personnel records.* Each job held by an employee is recorded in the employee's personnel file on one line in the computerized database. For each data category in the personnel file, the number of lines then equals the number of jobs held by the employee within Statoil, the number of jobs excluding those in Statoil, the number of lateral relations to which the employee has been attached and the number of courses completed, respectively.

Third, for a small sample (N=44), I inspected and coded printed personnel records in order to verify the validity of other measures, particularly the archival data mentioned above. A detailed investigation of the validation sample revealed that cross-unit transfers and intra-unit job transitions are both highly correlated with the number of promotions (about r=0.58), indicating that both transfers and transitions are frequently also promotions. Computerized personnel files do, however, include all nominal job changes, so that self-report data are reasonably more accurate measures of the actual number of job changes (see discussion on self-report measures). The number of internal courses (as measured by the number of data lines) is nearly perfectly correlated (about 0.95) with the number of days and weeks of training, indicating that the number of courses is a good measure of the amount of internal training.

4.8 Variable construction and summary statistics

Based on the considerations and findings presented above, I constructed communication and competence variables by adding scores on individual items into an index (see Table 4.12 for summary). Variables representing factual issues are basically measured with one item each. However, it should be noted, that the number of job transitions equals the total number job changes (item #311) minus the number of cross-unit transfers (see discussion above). Organizational tenure is the total number of years in the company (including the employee's current unit). Because organizational tenure is supposed to measure the total time-based exposure to the organization including time in current unit, organizational and unit tenure overlap by definition (correlation at 0.3). Working in a team and being affiliated with a lateral relation are categorical variables.

Table 4.12: Summary of measurement procedure

Variable	Type	Format	Response	Items/construction[a]	Level
1. Intraorganizational competence	Judgemental	Ratings	1 to 5	mean #231 to #237	Interval
2. Intraunit competence	Judgemental	Ratings	1 to 5	mean #241 to #246	Interval
3. Firm specific technical competence	Judgemental	Ratings	1 to 5	mean #271 to #278	Interval
4. Cross-unit transfers	Factual	Questions		#311, #312, #313	Ratio
5. Job transitions	Factual	Questions		#311 minus transfers	Ratio
6. Organizational tenure	Factual	Question		#301	Ratio
7. Unit tenure	Factual	Questions		#314, #315	Ratio
8. Teamwork	Factual	Question		#411 coded 0/1	Indicator
9. Cross-unit task forces	Factual	Question		#421	Ratio
10. Lateral relations	Factual	Question		#441 coded 0/1	Indicator
11. Intra-functional cooperation	Factual	Question	1 to 6	#541	Ratio
12. Cross-functional cooperation	Factual	Question	1 to 6	#542	Ratio
13. Cross-unit communication	Judgemental	Question	1 to 6	mean #511 to #516	Ratio
14. Intra-unit communication	Judgemental	Question	1 to 6	mean #531 to #536	Ratio

[a]Variable transformations will be analyzed in chapter 5

Table 4.13 presents means, standard deviations (SD) and correlations for all explanatory and outcome variables. Note that no variables have yet been transformed according to the hypotheses about non-linearities that were developed in a previous chapter (correlations will increase after transformation if non-linearities are present).

TABLE 4.13 Summary statistics. Outcomes and explanatory variables

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Intraorganizational competence	3.60	0.60													
2. Intra-unit competence	3.89	0.63	0.59 ***												
3. Firm specific technical competence	3.60	0.59	0.45 ***	0.34 ***											
4. Cross-unit transfers	1.60	1.83	0.26 ***	0.08 *	0.06										
5. Job transitions	2.22	2.22	0.17 ***	0.17 ***	0.05	0.11 **									
6. Organizational tenure	11.55	5.42	0.23 ***	0.14 ***	0.07	0.40 ***	0.49 ***								
7. Unit tenure	4.94	4.88	-0.09 *	0.10 **	-0.03	-0.36 ***	0.10 **	0.30 ***							
8. Teamwork [a]	0.70	0.46	0.13 ***	0.06	0.12 **	-0.03	-0.03	-0.01	0.02						
9. Cross-unit task forces	3.21	4.25	0.13 ***	0.05	0.17 ***	0.08 *	0.06	0.00	-0.07	0.32 ***					
10. Lateral relations[a]	0.62	0.48	0.05	0.06	0.05	0.15 ***	0.03	0.00	-0.19 ***	0.00	0.09 *				
11. Intra-functional cooperation	3.21	1.24	0.09 **	0.14 ***	0.07	0.02	-0.09 *	-0.02	-0.03	0.09 **	0.03	0.01			
12. Cross-functional cooperation	3.02	1.16	0.07	0.17 ***	0.05	0.06	0.06	0.07	-0.02	0.02	0.02	-0.01	0.02		
13. Inter-unit communication	3.70	1.04	0.34 ***	0.19 ***	0.22 ***	0.19 ***	0.06	0.07	-0.14 ***	0.24 ***	0.31 ***	0.09 *	0.13 **	0.09 *	
14. Intra-unit communication	3.82	0.83	0.28 ***	0.39 ***	0.15 ***	-0.02	0.03	0.06	0.03	0.15 ***	0.10 *	0.04	0.39 ***	0.18 ***	0.31 ***

[a]Indicator variable
*** significant at the 0.001 level (2-tailed).
** significant at the 0.01 level (2-tailed).
* significant at the 0.05 level (2-tailed).
N=680

5. TESTS OF HYPOTHESES

In this chapter, I will test the hypotheses developed in chapter 2 using the data described in chapters 3 and 4. Chapter 2 developed three theoretical propositions and produced three sets of hypotheses accordingly. The first set of hypotheses (Proposition 1) concerns the relation of each presumed causal variable with each of the three outcome variables. The second set of hypotheses (Proposition 2) concern the functional form of relations among explanatory and outcome variables. Finally, hypotheses about the effect of one causal variable on an outcome variable *relative* to its effect on another outcome variable (differential effects) are tested (Proposition 3).

I am using both descriptive and inferential analyses to test the hypotheses. Because non-experimental data require multivariate data analysis to control for spurious relations among variables, because most variables are measured at a continuous, interval or dichotomous scale, and because relations are assumed to be linear or can be transformed to a linear form, multiple linear regression is appropriate. Regression collapses a large amount of data into a small number of statistics that allow for a straightforward evaluation of hypotheses.

Relationships among variables estimated with a specific set of observations are not identical to the hypothesized true relationships. Estimates are associated with some degree of uncertainty or randomness. I am using significance tests to calculate the degree to which an observed relationship could, under specified conditions, result from chance alone. If the probability (the significance probability) that an observed relationship could result from chance factors does not exceed a specified maximum (the level of significance), 5% for example, the associated hypothesis is supported. No matter how small the significant probability, the test of significance itself does not rule out the possibility that results are idiosyncratic to a particular context, nor does the test of significance guarantee that the observed relationships are substantially important. Moreover, tests of significance do not rule out the possibility that a relationship between two observed variables is caused by an unobserved variable. If an appropriate measure of covariation between variables passes a test of significance, we should conclude that

the observed covariation is not due to random factors, that is, there is a systematic relation between the observed variables.

The sections below complete and discuss these analyses for the entire set of hypotheses. In the first section, I test hypotheses about functional form (Proposition 2) and implement appropriate transformations accordingly. The second section conducts a multiple regression analysis for each of the outcome variables separately in order to test hypotheses about effects on outcome variables (Proposition 1). In the third section tests of hypotheses about differences in effects on outcome variables are presented (Proposition 3). Finally, the results are summarized.

5.1 Tests of functional form

Theory and previous empirical research imply that the effect of experience on competence declines as information exposure accumulates. As information exposure accumulates, the probability of encountering novel, competence-enhancing information can be assumed to be steadily falling. In stable environments the individual will eventually know everything there is to know about a specific subject, and information will cease to have an effect on competence. That is, the effect of information on learning should be decreasing and approaching zero. I consequently hypothesized that relationships among variables measuring accumulated exposure to a specific domain and competence in that domain are positive, monotone, non-linear and asymptotic (Proposition 2).

Hypotheses about functional form concern the following explanatory variables: the number of cross-unit transfers, the number of job transitions, organizational tenure, unit tenure and the number of task forces during the past two years. These variables are factual measures at the ratio level of measurement. Organizational and unit tenure are measured on a continuous scale. Recall that measures of communication and cooperation were designed to capture non-linearities. Response categories for communication were not separated by even intervals. Each response category indicated a frequency of communication approximately two or three times higher than the previous response category, in effect a logarithmic scale. I screened these variables for

remaining non-linearities by comparing analysis of variance results with regression analysis results but did not detect any significant deviations from linearity for intra-unit and cross-unit communication.

A number of non-linear specifications are available. Proposition 2 implies that tests of non-linearity should be based on increasing at diminishing rate, monotonous, and asymptotic functions. For any range of values of the independent variables, the mathematical specification should be as easy to interpret as possible while incorporating the hypothesized properties. Multicollinearity limits the number of components for each independent variable that can be included in the mathematical expression. Each explanatory variable should thus be included only in one or two components of the equation. However, extensive trial and error is still required to find the best non-linear equation for a specific set of observations.

Previous research on learning curves has been particularly concerned with complete mathematical description of learning curves for highly specific tasks. Numerous studies have thus contributed to producing extensive knowledge about the shapes of learning curves across tasks, firms and industries. The conventional equation for the learning curve is $y=ax^{-n}$, where y is the labor hours needed to complete the xth unit of output, a is time needed to complete the first task, x is cumulative number of output units and n indicates the rate of learning. At $n = 0$ there is no improvement in performance, at $n = 1$ time needed to complete one unit of output falls 50% when cumulative output doubles (Yelle, 1979). A linear minus quadratic ($y=ax-bx^2$) specification has also been used to capture diminishing effects (e.g., Maranto & Rodgers, 1984). This function is however monotone only within a specific range of x.

Although traditional learning curve studies are not directly comparable to the present study, I decided to use a similar specification as a point of departure. My dependent variable is competence, which is expected to increase rather than decrease as in traditional learning curves. Asymptotic properties must also be introduced. The hyperbolic specification $y=a-b/x$ where y is the dependent, x the independent variable and a the asymptote, incorporates all hypothesized non-linear properties. In regression analysis, this equation may easily be estimated in linear form as $y=a+bz$ where $z=-1/x$

(the independent variable was actually transformed by $z=1/(x+1)$ to avoid division by zero). I decided to test the simplest hyperbolic model against the linear and if that model was rejected, I would try a small number of similar non-linear models. At least one of these should for example not be asymptotic, whereas two or three others should be variants of the hyperbolic (lower and higher learning rates).

I assessed alternative specifications in two steps: I first did separate regression analyses for alternative models compared to an analysis of variance baseline and then multiple regression analysis where alternative specifications for all explanatory variables are included in the same equation. Analysis of variance provides a precise measure of the degree to which a proposed functional form fits the actual observations, but does not incorporate a formal test for comparison of alternative specifications. Multiple regression provides a formal test of alternative specifications of functional form (including the linear specification), while controlling for other variables. I used the analysis of variance method to screen alternative specifications. The selected non-linear specification were then included in the complete regression model along with the linear specification for a formal test of hypotheses.

Alternative specifications can be assessed by comparing regression results to a model that is assumed to be linear with regard to x, and to analysis of variance results with no assumptions about linearity (i.e., mean values of y are compared across groups defined by values of x). Table 5.1 presents an example of analysis of variance assessment of linearity (see Appendix D for additional tables). We note that for both dependent variables no significant deviation from the curve remains after hyperbolic transformation of cross-unit transfers. This clearly indicates that the hyperbolic function $(1/(1+x))$ is an appropriate transformation for cross-unit transfers. Similar analyses were made for job transitions, organizational tenure, unit tenure and task force participation. For job-transitions no deviation from linearity was detected with this procedure.

For task-force I decided, based on this analysis, to use the square-root transformation instead. The square root is a positive monotone and diminishing (not asymptotic) function defined for all values equal to or larger than zero. The square-root transformation consequently partially conforms to Proposition 2. Due to the

inaccuracies related to the measurement of job transitions within a unit (see Measurement above), I conducted additional analyses for those respondents who did not transfer between units. This procedure ensures that all job transitions considered actually occurred within the same unit (in addition, this procedure removes the effects of cross-unit transfers). Results of analysis of variance test of linearity did not change within this group of employees.

TABLE 5.1: *ANOVA assessment of functional form: Cross-unit transfers*

	Predicting intra-organizational competence				
		SS	df	F	sign
Explained	Total	37.09	11	9.65	0.000
	Linear specification	25.90	1	74.15	0.000
	Deviation[a]	11.19	10	3.20	0.000
	Hyperbolic	33.86	1	96.97	0.000
	Deviation	3.22	10	0.92	0.512
Residual		313.27	897		
Total		350.35	908		
	Predicting firm-specific competence				
		SS	df	F	sign
Explained	Total	7.72	11	2.03	0.024
	Linear specification	2.08	1	6.00	0.014
	Deviation	5.64	10	1.63	0.094
	Hyperbolic	4.39	1	12.67	0.000
	Deviation	3.33	10	0.96	0.477
Residual		304.00	877		
Total		311.72	888		

[a]Variance (SS) explained in ANOVA, but not by regression.

Alternative specifications of an independent variable can be tested by including both specifications in the same regression equation. Alternatives can then be compared and assessed by inspecting standardized coefficients and significance levels of estimates. Due to multicollinearities (correlations at 0.7 – 0.9 between original and transformed variables), coefficient estimates may be unstable and conclusions about the relative impact of different variables in the equation may be uncertain. The collinearity diagnostic is included in regression results. Table 5.2 display regression analysis results for each dependent variable. Although all variables are included in the regression

analysis, only results for independent variables pertaining to the test of functional form are reproduced in these tables.

Table 5.2: Regression analysis test of functional form

	Intra-organizational	Intraunit	Firm-specific technical	VIF
Cross-unit transfer				
Linear	0.01	0.00	-0.09	3.5
Hyperbolic	0.14 *	0.14 *	0.10	5.1
Job-transitions				
Linear	0.15 **	0.18 ***	0.11	3.5
Hyperbolic	-0.13 *	-0.08	-0.12 *	3.4
Organizational tenure				
Linear	-0.03	-0.17 **	-0.06	3.8
Hyperbolic	0.20 ***	0.13 *	0.16 **	3.1
Unit tenure				
Linear	-0.01	0.09	-0.05	3.6
Hyperbolic	-0.03	0.15 **	0.06	2.3
Inter-unit task forces				
Linear	-0.09	-0.08	0.03	4.7
Square-root	0.12	0.06	0.06	5.7
R^2	0.28	0.26	0.09	
F	13.5 ***	12.10 ***	3.40 ***	

Other variables in equation not shown in table N = 680

Standardized regression coefficients * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Table 5.2 shows that the hyperbolic transformation of cross-unit transfer is significant for two of three outcome variables (hypotheses 3 and 4). Results further indicate that the relation between the number of job transitions and intraunit competence is in fact linear. The sum of a positive linear and negative hyperbolic suggests that the effect of job transitions on intraorganizational competence is accelerating from 1 to 4 jobs. After 3 to 4 jobs this negative effect is negligible. We also note that approximately the same applies to firm-specific technical competence (I did not specify a hypothesis for this relation). These relations are however not asymptotic. Based on these findings I decided to include the linear as well as the hyperbolic specification of job transitions in the final equation.

Hypotheses 13 and 14 about non-linear relation between organizational tenure and intraorganizational and firm-specific technical competence is supported by these results.

We should also note that intraunit competence is related to organizational tenure. The sum of a negative linear and a positive hyperbolic component implies that intraunit competence as a function of organizational tenure increases rapidly, plateaus (between 3 and 7 years) and then *decreases* slowly. The same relation with organizational tenure appear to be present with regard to intraorganizational and firm specific technical competence, these coefficicents are however not significant. This are indeed counterintuitive findings. In addition, alternative specifications of organizational tenure affects regression results for job transitions and inter-unit transfers. Based on these findings I decided to include the linear as well as the hyperbolic specification in the final equation.

The relation between unit tenure and intraunit competence clearly fits the hyperbolic specification (hypothesis 17). Despite the positive findings in the analysis of variance procedure, none of the coefficients related to the number of inter-unit task forces reach the 5% significance level in the regression analysis. We should however note that these variables are suffering from particularly high levels of multicollinearity (variance inflation factor above 5 or 10 is usually regarded as a rule of thumb) resulting in inflated standard errors. Table 5.3 compares the results of separate regression analyses for linear and non-linear specifications.

Table 5.3: Comparison of linear and non-linear specifications: Intraorganizational competence

	Linear only		Non-linear	
Variables[a]	B	Beta	B	Beta
(Constant)	2.43 ***		2.76 ***	
Inter-unit transfer	0.04 **	0.11	0.28 ***	0.15
Job transitions (linear)	0.01	0.05	0.04 **	0.15
Job transitions (hyperbolic)			-0.23 *	-0.13
Org. tenure	0.02 **	0.14	0.00	-0.03
			1.13 ***	0.20
Unit tenure	-0.01	-0.06	0.08	0.03
Inter-unit task forces[b]	0.002	0.02	0.02	0.03
R^2	0.25		0.28	
F	16.2 ***		17.0 ***	

[a]Other variables not shown in table [b]Square-root transformation
* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

The results in Table 5.3 support findings from Table 5.2 as well as from analysis of variance. As noted earlier there is one counterintuitive finding: the relation between job

transitions is weak from 1 to approximatly 4 jobs when it accelerates and remains linear throughout the range of observations. I obtained similar results for intraunit and firm specific technical competences. We should finally note that regression coefficients for inter-unit transfers and job transitions tend to *increase* when both the linear and the hyperbolic specification of organizational tenure is included in the regression equation. This indicates that the negative slope of organizational tenure above 4 to 7 years tend to mask the positive effect of job transitions and inter-unit transfers (organizational tenure correlates with inter-unit transfers and job transitions at 0.40 and 0.49 respectively). As noted earlier I conclude that the equation would be misspecified if only one of the two alternative specifications were included in the regression.

Summary

The analyses reported above support some hypotheses about non-linear, diminishing relations among explanatory and competence outcomes. All relations, except job transitions that tend to accelerate, appear to be diminishing. The effect of the number of task forces seems to be diminishing but not asymptotic. Table 5.4 presents a summary of the results in this section. I accordingly decided to use the transformations indicated in Table 5.4 in the remaining analyses of this dissertation.

TABLE 5.4 Non-linearities and selected specification

Explanatory variable (x)	Proposed non-linear model		Conclusion[a]	Selected model
Cross-unit transfers	Hyperbolic	1/(1+x)	partial support	hyperbolic
Job transitions	Hyperbolic	1/(1+x)	not supported: accelerating	linear & hyperbolic
Org. tenure	Hyperbolic	1/(1+x)	supported	linear & hyperbolic
Unit tenure	Hyperbolic	1/(1+x)	supported	hyperbolic
Task forces	Hyperbolic	1/(1+x)	not supported	
Task forces	Sq-root	$\sqrt{x}$	partial support	square-root

[a]Null-hypothesis: linear model

To illustrate the meaning of these transformations, I completed regression analyses with regard to intraorganizational competence. Bivariate regression analysis on the relation between organizational tenure and intraorganizational competence yields the equation $y=3.8-1.5/(1+x)$, where y is the level of intraorganizational competence and x is the

number of years in Statoil. The constant (3.8) is the upper bound of y, the dependent variable, which rapidly increases and approaches the asymptote. We can calculate the slope of the curve from the first derivative of the equation with regard to x, $y'=1.5/(1+x)^2$. The slope of this curve is for example 1.5 at tenure=0 (newcomers), 0.36 after one year, 0.17 after two years and 0.03 after six years. According to the estimated equation, the effect of tenure on intraorganizational competence plateaus between 6 and 10 years.

5.2 Tests of hypotheses about the effects on outcome variables

In the previous section, I investigated non-linear relations among outcome variables and selected explanatory variables. In this section, the purpose is to test hypotheses about effects on each outcome variable through the use of multiple regression, including all hypothesized explanatory variables and control variables. Control variables are selected to exclude possible spurious relations caused by the control.

Inspection of bivariate correlations and preliminary regression results for potential control variables showed that frequently used control variables, such as age and gender, are not correlated with any of the outcome variables. Age is, however, highly correlated with organizational tenure (r=0.57). On this basis, I decided not to include age and gender. Years of education is correlated with several career factors, but not correlated with any outcome variable. Having a degree in business (siviløkonom or equivalent) appears to be the only educational variable that both affects outcome variables and is correlated with explanatory variables, and this variable is consequently included in the regression analyses. (It is specified as an indicator variable, while all other educational categories is the reference category. About 10% of the sample have a business degree.) Inclusion of archival data on internal training (number of courses attended) and work experience outside Statoil, although correlated with other independent variables, did not alter the results. (Due to a larger proportion of missing data, I excluded archival data from the final analyses.) Finally, job type (manager vs. professional) and job content (technical vs. others) are related to both explanatory and outcome variables.

In this section I report regression analyses for each of the three outcome variables. To make models comparable, the same set of independent (explanatory and control) variables are included for all outcome variables. Regression results for all outcome variables are summarized and compared in the concluding paragraph of this section.

5.2.1 INTRAORGANIZATIONAL COMPETENCE

Table 5.5 presents the results of multiple regression for intraorganizational competence. Each category of explanatory variables is first investigated separately, then an equation with all variables is estimated and finally selected control variables are included. Note that coefficients associated with transformed variables should be interpreted with care: the unstandardized coefficient is the change of the dependent variable associated with a one unit change in the transformed variable rather than the underlying variable.

Cross-unit transfers, job transitions, organizational tenure, cross-unit communication and intra-unit communication are positively related to intra-organizational competence as hypothesized (hypotheses 1, 6, 11, 35 and 38). Note however that the relation with job transitions is accelerating rather than diminishing (see previous section on functional form). We also observe that the effect of cross-unit task forces and intra-functional cooperation disappears when communication is introduced (hypothesis 21). This is due to high correlations between cross-unit task forces and cross-unit communication ($r=0.38$) and between intra-functional cooperation and intra-unit communication ($r=0.38$). Information about an employee's involvement in cross-unit task forces and intra-functional cooperation does not provide predictive information beyond knowledge about that person's communication activities. These results further suggest that these variables are causally related. More specifically, cross-unit task forces may, by increasing cross-unit communication, have an indirect effect on cross-unit competence.

Due to the differences among variables in measurement units, unstandardized coefficients are not readily comparable. The largest standardized coefficients are obtained for cross-unit communication, tenure, intra-unit communication, transfers and job transitions. These coefficients show that they account for roughly the same proportion of variation in the dependent variable. In addition to hypothesized relations,

the analyses indicate that intra-unit communication affects competence and that business graduates on average possess more intra-organizational knowledge than other employees.

5.2.2 INTRAUNIT COMPETENCE

Table 5.6 presents the results of multiple regression for intra-unit competence. Each category of explanatory variables is first investigated separately, then an equation with all variables is estimated and finally selected control variables are included.

Job transitions, unit tenure, cross-functional cooperation and intra-unit communication affect intra-unit competence as hypothesized (hypotheses 7, 16, 31 and 39). Note however that only the linear component of job transitions reaches the 5% significance level. No effect of working in a team is detected. The effect of intra-functional cooperation (hypothesis 29) disappears when other variables are controlled for, most likely due to a high correlation with intra-unit communication ($r=0.37$). This suggests that intra-functional cooperation, by increasing intra-unit communication, has an indirect effect on intra-unit competence. More surprising is the effect of cross-unit communication and lateral relations, and the effect of cross-unit transfers (which disappears when I control for the type of job). We should also note the negative linear component of organizational tenure. As noted in section 5.1, this means that the net effect of the linear and the hyperbolic component is negative after about 5 or 6 years in the organization.

Due to the differences among variables in measurement units, unstandardized coefficients are not readily comparable. The largest standardized coefficients are obtained for intra-unit communication, unit tenure and job transitions. These variables account for a substantial proportion of variation in the dependent variable. The standardized coefficient for intra-unit communication is 3-4 times larger than for other variables. Finally, we may note that managers on average possess more whereas employees in technical jobs possess less intra-unit competence.

5.2.3 FIRM SPECIFIC TECHNICAL COMPETENCE

Table 5.7 presents the results of multiple regression for firm specific technical competence. Each category of explanatory variables is first investigated separately, then an equation with all the variables is estimated and finally selected control variables are included.

When all variables are included, job transitions, organizational tenure, cross-unit task forces and cross-unit communication relate to firm specific technical competence as expected (hypotheses 12, 22 and 36). Both the linear and the hyperbolic component of job transitions are significant at the 5% level (one-tailed tests). As noted in section 5.1, this means that the slope is increasing with the number of job transitions. Intra-unit communication is not significant at the 0.05 level when all explanatory variables are included in the analysis (hypothesis 40). This is probably caused by a high correlation (0.39) with intra-functional cooperation. I hesitate to draw definite conclusions about intra-unit communication. The remaining hypotheses 2, 19, 27, 30 and 32 are not supported by these results.

Due to the differences among variables in measurement units, unstandardized coefficients are not readily comparable. The largest standardized coefficients are obtained for organizational tenure, cross-unit communication, job transitions and task forces. These coefficients show that they account for roughly the same, modest proportion of variation in the dependent variable. Standardized coefficients are consistently smaller for this outcome variable compared to the preceding analyses. The multiple correlation coefficient (R^2) is relatively small, indicating that this set of variables provides little predictive information.

TABLE 5.5. Predicting intraorganizational competence. Multiple regression

	Career factors	Structures	Communication	All variables	Including control var.	
	b	b	b	b	b	beta[a]
Inter-unit transfers (hyperbolic)	0.41 ***			0.36 ***	0.28 ***	0.15
Job transitions (linear)	0.04 **			0.04 **	0.04 **	0.15
Job transitions (hyperbolic)	-0.16			-0.18 *	-0.23 *	-0.13
Org. tenure (linear)	0.00			0.00	0.00	-0.03
Org. tenure (hyperbolic)	1.07 **			1.09 ***	1.13 ***	0.20
Unit tenure (hyperbolic)	-0.07			-0.07	-0.08	-0.03
Teamwork[b]		0.06		0.05	0.06	0.04
Inter-unit task forces (sq-root)		0.09 ***		0.01	0.02	0.03
Lateral relations[b]		0.05		-0.04	-0.01	-0.01
Intra-functional cooperation		0.04 *		0.00	0.00	0.00
Cross-functional cooperation		0.03 *		-0.01	-0.01	-0.03
Inter-unit communication			0.16 ***	0.12 ***	0.12 ***	0.21
Intra-unit communication			0.14 ***	0.15 ***	0.12 ***	0.17
Business degree[b]					0.14 *	0.08
Manager[b]					0.14 **	0.11
Work content[b]					-0.09 *	-0.08
Constant	3.92 ***	3.17 ***	2.47 ***	2.75 ***	2.76 ***	
Adj R-sq	0.12	0.04	0.16	0.24	0.26	
F-ratio	15.8 ***	6.9 ***	60.4 ***	17.1 ***	16.0 ***	

[a]Standardized coefficients
[b]Indicator variable
N=679

* $p < 0.05$ (one-tailed tests)
** $p < 0.01$
*** $p < 0.001$

TABLE 5.6. Predicting intra-unit competence. Multiple regression

	Career factors	Structures	Communication	All variables	Including control var.	
	b	b	b	b	b	beta[a]
Inter-unit transfers (hyperbolic)	0.27 ***			0.25 **	0.18 *	0.09
Job transitions (linear)	0.04 *			0.05 **	0.05 **	0.17
Job transitions (hyperbolic)	-0.03			-0.11	-0.15	-0.08
Org. tenure (linear)	-0.01 *			-0.02 *	-0.02 *	-0.13
Org. tenure (hyperbolic)	0.74 *			0.74 *	0.76 *	0.13
Unit tenure (hyperbolic)	0.53 ***			0.53 ***	0.52 ***	0.19
Teamwork[b]		0.03		0.00	0.01	0.01
Inter-unit task forces (sq-root)		0.03		-0.01	-0.01	-0.01
Lateral relations[b]		0.07		0.04	0.07 *	0.06
Intra-functional cooperation		0.07 ***		0.01	0.02	0.04
Cross-functional cooperation		0.09 ***		0.05 **	0.04 *	0.07
Inter-unit communication			0.05 *	0.04 *	0.04 *	0.07
Intra-unit communication			0.28 ***	0.25 ***	0.22 ***	0.29
Business degree[b]					0.06	0.03
Manager[b]					0.15 **	0.12
Work content[b]					-0.09 *	-0.07
(Constant)	4.34 ***	3.31 ***	2.66 ***	2.97 ***	3.00 ***	
Adj R-sq	0.07	0.04	0.16	0.22	0.24	
F-ratio	9.5 ***	7.7 ***	63.6 ***	15.8 ***	14.2 ***	

[a]Standardized coefficients
[b]Indicator variable
N=679

* $p < 0.05$ (one-tailed tests)
** $p < 0.01$
*** $p < 0.001$

TABLE 5.7. Predicting firm specific technical competence. Multiple regression

	Career factors	Structures	Communication	All variables	Including control var	
	b	b	b	b	b	beta[a]
Inter-unit transfers (hyperbolic)	0.16 *			0.082	0.09	0.05
Job transitions (linear)	0.03 *			0.030 *	0.03 *	0.11
Job transitions (hyperbolic)	-0.19			-0.207 *	-0.20 *	-0.11
Org. tenure (linear)	-0.01 *			-0.011	-0.01	-0.10
Org. tenure (hyperbolic)	0.94 **			0.939 **	0.93 **	0.17
Unit tenure (hyperbolic)	0.07			0.077	0.08	0.03
Teamwork[b]		0.05		0.034	0.03	0.03
Inter-unit task forces (sq-root)		0.09 ***		0.052 *	0.05 *	0.09
Lateral relations[b]		0.05		0.022	0.02	0.01
Intra-functional cooperation		0.03		0.01	0.01	0.03
Cross-functional cooperation		0.02		0.01	0.01	0.02
Inter-unit communication			0.11 ***	0.080 ***	0.08 ***	0.14
Intra-unit communication			0.06 *	0.048	0.05	0.07
Business degree[b]					-0.02	-0.01
Manager[b]					-0.02	-0.01
Work content[b]					0.02	0.02
(Constant)	3.80 ***	3.26 ***	2.97 ***	3.070 ***	3.07 ***	
Adjusted R-square	0.02	0.04	0.05	0.07	0.06	
F-ratio	2.90 **	5.90 ***	19.70 ***	4.80 ***	3.95 ***	

[a]Standardized coefficients
[b]Indicator variable
N=679

* $p < 0.05$ (one-tailed tests)
** $p < 0.01$
*** $p < 0.001$

5.2.4 SUMMARY AND COMPARISON

In the preceding paragraphs, I presented and discussed separate regression analysis results for three outcome variables. Each analysis included the same set of independent variables. Table 5.8 presents a comparison of results for all outcome variables (only unstandardized coefficients and significance probabilities are shown). We note that the multiple correlation coefficient is much larger for intraorganizational and intraunit competence than for firm specific technical competence.

TABLE 5.8: **Multiple regression results, comparison of all outcomes**

	Intraorg. competence	Intra-unit competence	Firm specific tech. comp.
	b	b	b
Cross-unit transfer[a]	0.28 ***	0.18 *	0.09
Job transitions (linear)	0.04 **	0.05 **	0.03 *
Job transitions[a]	-0.23 *	-0.15	-0.20 *
Org. tenure (linear)	0.00	-0.02 *	-0.01
Org. tenure[a]	1.13 ***	0.76 *	0.93 **
Unit tenure[a]	-0.08	0.52 ***	0.08
Teamwork[c]	0.06	0.01	0.03
Cross-unit task forces[b]	0.02	-0.01	0.05 *
Lateral relations[c]	-0.01	0.07 *	0.02
Intra-functional cooperation	0.00	0.02	0.01
Cross-functional cooperation	-0.01	0.04 *	0.01
Cross-unit communication	0.12 ***	0.04 *	0.08 ***
Intra-unit communication	0.12 ***	0.22 ***	0.05
Business degree[c]	0.14 *	0.06	-0.02
Manager[c]	0.14 **	0.15 **	-0.02
Work content[c]	-0.09 *	-0.09 *	0.02
(Constant)	2.76 ***	3.00 ***	3.07 ***
R^2	0.26	0.24	0.06
F	16.0***	14.2***	3.95***

[a]Hyperbolic transformation
[b]Square root transformation
[c]Indicator variable

*** $p < 0.001$
** $p < 0.01$
* $p < 0.05$

N = 680

Campion et al. (1994) found that job rotation affected administrative competence but not technical competence, whereas promotions did not have any effect on either. Effects

of job history obtained in this study appears to be consistent with Campion and associates' findings and with Morrison and Brantner's (1992) findings that the number of previous jobs did not have any effect on learning in the current job. Campion and associates did not, however, find any effects of tenure, which is inconsistent with previous research (Morrison & Brantner, 1992; Schmidt et al., 1986) as well as with the present results.

These results largely support hypotheses about the effects of communication. Although findings are not perfectly comparable, the present findings are essentially consistent with previous research on organizational learning (Darr et al., 1995) and diffusion of innovations (Rogers, 1983).

In Chapter 4 I noted that it is not possible to calculate the exact number of job transitions within the *current* unit. Although a most unfortunate error, it does not appear to affect the results presented above: About 330 respondents never transfered. Separate regression analyses within this subsample produced virtually the same results as the analyses based on the full sample, with a few interesting exceptions: For those that never changed unit, intraunit communication does not seem to affect intraorganizational competence; the number of jobs is *negatively* related to firm specific technical competence; and job type/content is not related to intraunit competence. These differences may be due both to possible biases introduced in the measurement procedure as well as true differences in learning environments between these categories of employees. Future research should address both issues.

Contrary to conventional wisdom, I found minimal support for hypotheses about structural factors when controlling for actual communication. Results do, however, suggest that structures, by facilitating interpersonal relations and triggering communication, have important indirect effects on competences.

In the next section, I investigate hypotheses about differences among effects.

5.3 Tests of differential effects

In the previous section, I tested hypotheses regarding effects on each outcome variable. In this section, I am testing hypotheses about differences among these effects - differential effects. Differential effects can be investigated *informally* by comparing coefficients produced in three separate regression analyses. Because the outcome variables in question are conceptually similar and operationalized in a similar fashion, differences between regression coefficients indicate differences in the substantial impact on different outcome variables.

A *formal* test is required to establish that the obtained differences between effects are larger than what could be expected to occur by chance. Structural equation modeling (SEM) provides a formal test of differences among effects. Estimates for a structural equation model where coefficients are assumed to be equal will be compared to one where no assumptions about coefficients are made. Structural equation modeling allows for more than one outcome variable and facilitates a test of the hypothesis that effects are in fact different.

Hypotheses about differential effects are tested with a structural equation model (SEM) procedure as follows. A SEM representing the null-hypothesis that effects are in fact equal, is specified and estimated with appropriate software (LISREL). In the LISREL model, I specify the null-hypothesis as "equality constraints" on relevant parameters. Coefficients that are expected to be different are constrained to be equal.

I reject the null hypothesis that effects are in fact equal if model diagnostics indicate that model fit (the degree to which the model is able to predict actual observations) can be improved by relaxing a particular equality constraint. LISREL calculates a likelihood-ratio chi-square measure of divergence between model and observations. The expected reduction in this chi-square "badness-of-fit" statistic if a particular parameter constraint is relaxed, is called a "modification index". If the model badness-of-fit measure (the chi-square statistic) decreases significantly when an equality constraint is relaxed, the null-hypothesis that effects are not different is rejected and the alternative hypothesis that effects are in fact different will be accepted. In the present analysis, all constraints representing all null-hypotheses are initially in the model. The constraint related to the

largest (statistically significant) modification index is removed and the model is re-estimated. If reduction in chi-square is statistically significant, the null-hypothesis is rejected for this particular parameter.

I repeated this stepwise procedure until no significant modification indices remained. Null-hypotheses represented by remaining equality constraints are not rejected. There are no restrictions on correlations among dependent variables. SEM estimates are based on the same variables, variable specification and the same observations as in the previous sections.

The SEM was estimated with the LISREL software. Initial (all equality constraints) and modified (all significant constraints relaxed) solutions are reported. Table 5.9 presents coefficients, modification indices and model chi-square for the initial solution. A column represents each structural equation. There are no other constraints than those implied by the hypotheses, hence no modification indices are computed for other coefficients. (Note that we are primarily concerned with changes in the model fit statistic, and not with the actual level of fit.)

TABLE 5.9. Initial solution (all constraints)

	Intraorg. competence		Intraunit competence		Firm specific tech. competence	
	b	MI	b	MI	b	MI
Cross-unit transfer (hyperb.)	0.13***	9.93	0.07*		0.13***	9.93
Job transitions (linear)	0.17***	0.88	0.17***	0.88	0.12*	
Job transitions (hyperb.)	-0.11*	1.31	-0.11*	1.31	-0.14**	
Org. tenure (linear)	-0.09*	8.70	-0.14**		-0.09*	8.70
Org. tenure (hyperbolic)	0.20***	7.74	0.14**		0.20***	7.74
Unit tenure (hyperbolic)	-0.04		0.19***		0.04	
Teamwork	0.04		0.02	0.04	0.02	0.04
Cross-unit task forces	0.06*	0.18	-0.01		0.06**	0.18
Lateral relations	0.00	0.03	0.06*		0.00	0.03
Intra-functional cooperation	0.02		0.05*	3.74	0.05**	3.74
Cross-functional cooperation	-0.04		0.05*	2.86	0.05**	2.86
Cross-unit communication	0.16***	3.84	0.09**		0.16***	3.84
Intra-unit communication	0.17***	1.45	0.17***	19.8	0.17***	12.64
Business degree	0.07*		0.02		-0.01	
Manager	0.11***		0.16***		-0.06*	
Work content (technical)	-0.09**		-0.07*		0.03	

*p<0.05 MI = modification index

**p<0.01 MI measures the predicted decrease in chi-square if constraint is relaxed

***p<0.001 MI > 3.84 significant at 0.05 (chi-square distribution with 1 degree of freedom)

Chi-square (df=13) 47.12 (significant at <0.00001)

After three modifications and re-estimations, no modification indices above the critical value (3.84) at the 0.05 significance level remained. Table 5.10 presents the final results. The present analysis supports two hypotheses about differential effects: effects of intra-unit communication on intra-unit vs. technical competence (hypothesis 41); and effects of cross-unit transfers on intra-organizational vs. technical competence (hypothesis 5). The remaining hypotheses regarding differential effects are not supported by the results.

TABLE 5.10. Modified solution

	Intraorg. competence		Intra-unit competence		Firm specific tech. comp.	
	b	MI	b	MI	b	MI
Cross-unit transfer (hyperb.)	0.18***	#	0.11**		0.03	#
Job transitions (linear)	0.17***	1.81	0.17***	1.81	0.11*	
Job transitions (hyperb.)	-0.12**	2.28	-0.12**	2.28	-0.12*	
Org. tenure (linear)	-0.09*	2.67	-0.14**		-0.09*	2.67
Org. tenure (hyperb.)	0.19***	2.06	0.14**		0.19***	2.06
Unit tenure (hyperb.)	-0.02		0.20***		0.01	
Teamwork	0.03		0.02	0.82	0.02	0.82
Cross-unit task forces	0.06*	1.61	-0.01		0.06*	1.61
Lateral relations	0.00	1.05	0.05*		0.00	1.05
Intra-functional cooperation	0.03		0.04*	0.04	0.04*	0.04
Cross-functional cooperation	-0.04		0.05*	1.01	0.05*	1.01
Cross-unit communication	0.18***	0.50	0.06*		0.18***	0.50
Intra-unit communication	0.16***	#	0.29***	#	0.06*	#
Business degree	0.07*		0.03		0.00	
Manager	0.11**		0.12***		-0.01	
Work content	-0.08**		-0.07*		0.03	

*p<0.05 MI = modification index

**p<0.01 MI measures the predicted decrease in chi-square if constraint is relaxed

***p<0.001 MI > 3.84 significant at 0.05 (chi-square distribution with 1 degree of freedom)

initial constraint relaxed (effects not equal)

Chi-square (df=10) 10.07 (not significant at 0.05)

N=680

Summary

Although only a small number of hypotheses were supported, the notion of differential effects on learning and competences seems worth exploring. A preliminary analysis using pairwise *differences* between individual scores on outcome variables was regressed on the independent variables. This regression analysis produced virtually the same results as the LISREL procedure reported above. The preliminary regression analysis identified additional unexpected differential effects that were not tested above.

These findings are consistent with Campion and associates' (1994) finding that rotation affected administrative competence but not technical competence. In addition, several differential effects appear to be present in Campion and associates' data. Similarly,

Motowidlo and Scotter (1994) found differential effects of experience, ability and a number of personality variables on task and contextual performance.

It should finally be noted that the proportion of variance (as measured by the R^2) accounted for by the included independent variables is consistently and substantially smaller for firm specific technical competence than for intra-organizational and intra-unit competence. This suggests that task-specific competences are mainly affected by variables not included in the present study, which in turn means that task specific competences are affected by a different set of variables than non-task-specific competences (that is, differential effects). This is consistent with Campion and associates' (1994) results where career-related variables achieved a very small R^2 with regard to technical competence but a substantially larger R^2 with regard to administrative and business competence. At the present stage of research, we can only speculate about these not-included variables.

5.4 Summary of hypothesis testing

In this chapter I have tested the hypotheses that were developed in chapter 2 (see summary in table 5.22). I tested three sets of hypotheses, each set corresponding to a theoretical proposition. Hypotheses deduced from Proposition 1 concern the effects of specific variables on each competence outcome. Proposition 2 asserts that these relationships should be diminishing and asymptotic, whereas Proposition 3 claims that a specific explanatory variable should have different effects on different competences.

In order to incorporate appropriate transformations, I first completed tests of functional form (proposition 2). I investigated the functional form of the relations between independent and dependent variables by transforming the independent variables according to the hypotheses and then assessed alternative specifications of the independent variables through ordinary analysis of variance (bivariate) as well as multiple regression. Hypotheses about functional form are basically supported. Based on this analysis, I decided to transform career-related factors (hyperbolic) as well as cross-unit task forces (square root).

Hypotheses relating to Proposition 1 were tested with multiple linear regression. I included all explanatory variables (see table 5.11) as well as control variables (manager, job content and business education) for all outcome variables. Some hypotheses are supported (at the 0.05 level of significance), others are not (do not reach the 0.05 level). In addition, results suggest some indirect effects as well as ambiguities due to collinearities among independent variables.

Hypotheses about differential effects (Proposition 3) were tested through a structural equation model (LISREL) with three dependent variables. Two hypotheses are supported.

Table 5.11 Summary of hypothesis testing

		Proposition 1			*Proposition 2*	*Proposition 3*
Antecedent variables		**Outcomes**			**All outcomes**	
Category	Variable	Intraorg. compet.	Intra-unit compet.	Firm-specific tech. comp.	Functional form	Differential effects
Career-related factors	Cross-unit transfers	supported		not supported	Supported	supported
	Job transitions	supported	supported		Not supported	not supported
	Org. tenure	supported		supported	Supported	not supported
	Unit tenure		supported		—"—	
Structures	Team		not supported	not supported		not supported
	Cross-unit task forces	not supported (indirect effect?)		supported	partial support (diminishing)	not supported
	Lateral relations	not supported		not supported		not supported
	Intra-functional cooperation		not supported (indirect effect?)	not supported		not supported
	Cross-functional cooperation		supported	not supported		not supported
Communi-cation	Cross-unit communication	supported		supported		inconclusive
	Intra-unit communication	supported	supported	not supported (inconclusive)		supported

blank cells: No hypothesis specified

6. DISCUSSION AND IMPLICATIONS

In this closing chapter I will discuss the theoretical and practical implications of the results presented above. Section 6.1 summarizes findings with regard to concepts and propositions developed in chapter 2. The next section discusses limitations of this study with an emphasis on explanatory mechanism, causal structure and measurement procedure. Section 6.3 outlines practical implications for employers as well as employees. Finally, in section 6.4, I suggest directions for further research.

6.1 Conclusions and implications for theory

The research reported here is based on developments in two areas. First, recent conceptual developments are concerned with the multidimensionality of competence (Nordhaug, 1993; Sonntag & Schäfer-Rauser, 1993) and work performance (Motowidlo & Scotter, 1994; see also Dyne & LePine, 1998). Second, concern with the specificity or multidimensionality of experience has also emerged (Quiñones et al., 1995; see also Tesluk & Jacobs, 1998). Although several researchers have proposed that different dimensions of performance outcomes have different antecedents (Murphy & Shiarella, 1997; McCloy et al. 1994), virtually no research has investigated relations among multiple experiences and multiple competence outcomes. Moreover, learning curve studies have proceeded without a clear theoretical understanding of experience (as measured by time or volume). I accordingly extended the notion of experience and proposed that competence acquisition occurs as a result of exposure to information.

The main purpose of this study has been to investigate effects of different types of exposure on different competences. More specifically, I developed three propositions that extend previous research by measuring domain specific exposure and domain specific competence. Propositions 1 through 3 were intended to make successively more accurate predictions about relations among variables and should thus be more falsifiable (Meehl, 1991). Proposition 1 makes claims about effects on outcome variables, proposition 2 claims that these effects have specific mathematical properties, and finally proposition 3 makes claims about the relative size of effects on different outcomes.

Together, these propositions constitute a component of a theory about competence acquisition in the workplace.

Proposition 2 states that competence is increasing at a decreasing rate. The results obtained in this study consistently support Proposition 2. Thus the well-known notion of diminishing returns to experience has been successfully extended to a number of types of exposure. This supports my claim that the notion of information exposure should replace the notion of experience. Moreover, the presence of diminishing effects support the basic proposition that learning occurs through accumulation (cf. Mazur & Hastie, 1978). The present results specifically indicate that learning plateaus occur around six years, this corresponds to learning plateaus identified by previous research across a variety of domains.

A theory of competence acquisition in the workplace should hence incorporate the notion of learning through accumulation and the associated phenomena of diminishing returns and plateauing. The findings in particular indicate that the actual amount of exposure makes a difference, a mere affiliation or relation to a source or domain of information provides little data about the learning taking place. A theory of competence acquisition in the workplace must take into account the quantitative aspects of learning. The findings further indicate that employees' intraorganizational and intraunit competence plateaus after several years in the organization. This implies that employees' possess substantial competences in these areas which, in addition to its practical importance, means that it is an area deserving theorizing as well as empirical research.

Proposition 1 asserts that accumulation of domain specific exposure affects domain specific competence levels. The results show that variables either have the hypothesized effect or no effect at all, with one important exception: Lateral relations affect intra-unit competence only. Detailed, setting-specific investigation may be needed to understand why lateral relations have such a counterintuitive effect. In addition, several structural variables appear to have an indirect effect via the actual communication. I accordingly conclude that Proposition 1 is essentially supported and that multiple competences are related to multiple experience measures. Further research is needed to clarify if and how

other factors affect communication, which in turn affects competences and possibly other outcomes of interest. Compared to previous research, a more precise specification of what is actually learned and of the sources of information exposure are thus the main contributions of this study.

Finally, Proposition 3 claims that learning effects are different for different competence outcomes (differential effects). Results provided some support for hypotheses derived from this general proposition. In addition, a number of unanticipated (although somewhat trivial) differential effects were uncovered by the statistical analyses. Although no effort has been invested in rigorous tests of differential effects, previous research has provided implicit support for differential effects. I therefore conclude that the notion of differential learning effects, given its solid theoretical basis and relative novelty (Meehl, 1991), should not be abolished. Improved measurement and further research, possibly with regard to different outcome variables, is needed to draw definite conclusions.

There is virtually no previous research on competences as outcomes of learning in the work-place, and existing research is fragmented and has not been guided by a coherent or shared conceptual framework. The current fine-grained definition of competence outcomes (cf. Nordhaug, 1993) has not been applied in previous empirical research. The question remains whether such a fine-grained typology adds value. A more fine-grained typology adds virtually no value if it is merely a typology. What do we gain by distingusihing among several competence types?

One possible criterion of the appropriateness or value-added of a conceptual typology, would be that variables distinguished by the framework have differential relations with determinants and consequences (Conway, 1996; Motowidlo et al., 1997). Different competences may have different performance implications. In addition, performance implications may depend on the type of job. Intraorganizational competence for instance may have the largest effect on job performance in managerial jobs. Different competences may be acquired in different ways. This is precisely what Proposition 3 is about. Although most of the hypotheses derived from Proposition 3 did not obtain empirical support, the statistical analyses revealed unique sets of antecedent variables

for each outcome variable. In other words, if a variable derived from a specific typology is involved in a pattern of causal relations distinct from other variables derived from that typology, we can claim that the typology adds value compared to conceptual frameworks where those variables are not distinguished. This pattern of relations would not have been discovered if a less fine-grained typology of competences had been applied. This suggests that the typology does in fact add value by capturing relevant empirical phenomena.

Findings based on data collected within one specific setting raises question about the generalizability to other industries, organizations or other types of jobs and employees. In fact, generalizing beyond learning in the workplace is also an issue. It is reasonable to assume that the less similar the context, the less specific the generalization. Highly specific findings such as time to plateau probably depend on a range of contingencies (e.g., industry, size of organization) and can only be generalized with great care. Highly general conclusions, in particular those relating to propositions, can, with minor adjustments, be generalized to any context of learning. We can reasonably assume that in all but the smallest organizations there are notable differences between competence types. I accordingly believe that conclusions relating to the competence typology can be generalized to any work organization, in other words, that it should be incorporated into a theory of competences and competence acquisition in work organizations.

This study generalized the notion of experience into a concept of learning through information exposure. Based on this, I identified a number of variables that were expected to affect learning in essentially the same way as traditional measures of experience (notably time and volume). Learning curve properties were detected for most variables. I accordingly conclude that the concept of exposure to different domains (technical, corporate, unit) should replace the notion of experience and be incorporated into theory about competence acquisition in the workplace. Theory development in this field should make an effort to identify other relevant domains.

6.2 Limitations

According to falsificationist philosophy of science, lack of empirical support for a theoretical prediction is regarded as proof that the theory is in fact false, whereas support merely indicates that the theory, as well as all other theories with similar predictions, may be true. Claims about causal relations may obtain empirical support even if the claims are basically false. On the other hand, hypotheses may fail to obtain support even if they are true: The quality of the theory itself is only one reason why hypotheses do not obtain empirical support (Meehl, 1991). Sampling, random measurement error and inadequate operationalizations may in particular obscure true relations. By subscribing to a rigid falsifactionist procedure we risk throwing away the right theory for the wrong reasons. In this section, I consider limitations in the following areas: appropriateness of the explanatory mechanism, causal direction, measurement as well as model specification.

6.2.1 EXPLANATORY MECHANISM

The point of departure for this study was the proposition that learning results from the information to which the employee has been exposed. In particular, I studied the effect of accumulated exposure to information in different domains. This conception of learning encompasses a number of unobserved processes, and there is a relatively long causal chain from crude measures of information domains to specific survey measures of competence. Beyond approximate identifications of domains, no effort was made to capture additional complexities of learning such as the integration of pieces of information or the temporal structure of information.

Although predictions about effects and functional form (propositions 1 and 2) received substantial support, it may be argued that the process of learning is not adequately accounted for. It can, for example, be shown that different types of learning as well as different types of learning outcomes are treated as one. This study does not for instance distinguish explicitly between learning from direct experience, learning from the experience of others and acquisition of institutionalized knowledge (Levitt & March, 1988). It can possibly be argued that different types of learning are differentially related

to different competence outcomes. Nor do I distinguish between knowledge about means-ends relations and knowledge about simple facts (declarative knowledge). It can possibly be shown that the information required to acquire these types of knowledge is radically different. Learning about means-ends relations in particular requires trial and error with outcome feedback. If feedback information is delayed or ambiguous, no learning or superstitious learning may result. Complexities related to the interaction between sources of learning (direct experience, others), types of knowledge (causal, factual) and the quality of information (e.g., feedback, temporal structure) are contained in the black box of "information exposure". Although the explanatory mechanism assumed in this study is appropriate, its capacity to capture all details of the intervening learning process is clearly limited.

6.2.2 CAUSAL MODEL

Causal order

Claims about causal relations among observed variables are generally based on three premises: covariation, temporal order (causal direction), and exclusion of alternative explanations of covariation (non-spuriousness). Non-experimental studies do not allow unambiguous conclusions about non-spuriousness. Causal direction can be established by building temporal order into the design or by way of theoretical reasoning. In this section I discuss limitations on claims about causal relations variable by variable.

Time-based measures of information exposure (organizational and unit tenure) do not represent substantial ambiguities with regard to causal order. Although the extent of employee firm specific competences is an incentive for the employee to remain with the organization (Kalleberg & Reve, 1993), the observed mathematical relation between time and competence could not be produced by selection alone.

The causal relation between job-history and competences might be contested. One might for example argue that extensive intraorganizational competence increases the likelihood of obtaining a better job inside the company. This can result both from better knowledge about job openings in different parts of the organization and from decision-

makers' belief that the employee, due to his or her competence, is suited for a particular job. Competent employees are thus more likely assigned to challenging jobs and managerial jobs.

Anecdotal evidence suggests that the opposite mechanism may be operating: Managers are not happy to surrender competent employees to other departments or units, whereas less competent employees may be promoted as candidates for job openings in a different part of the organization. The net effect of these mechanisms is difficult to predict. The empirical findings show that organizational rather than technical competence is related to cross-unit transfers, whereas job transitions (including promotions) are not strongly related to any outcome. These results are consistent with Campion et al's (1994) findings that rotation but not promotion was related to business and administrative competences. If selection rather than learning is the key process, cross-unit transfers should be related to both intraorganizational and technical competence whereas other job transitions should be related to all competence outcomes. Given that these results as well as previous research (notably Campion et al., 1994) do not provide clear support that selection rather than learning occurred, I conclude that the causal direction specified is essentially correct.

Similar reasoning applies to participation in cross-unit task forces. Such task forces are usually composed of relatively competent employees from different parts of the organization. Selection effects may thus account for some of the observed covariation with firm specific technical competence. We further note that a correlation at 0.31 with cross-unit communication suggests that these employees have wide personal networks or that extensive communication is caused by their participation in task forces. It may also be that employees who communicate frequently through extensive networks are highly visible in the intraorganizational environment and are more likely to be recruited to task forces. The correlation between task forces and intraorganizational competence can not, however, reasonably be ascribed to selection. Although selection effects can not be ruled out, I maintain that the relations between task-force participation and competences can not be due to selection alone. In particular, the causal model may be slightly revised by incorporating an indirect effect of task forces (via communication)

on competences. This modification may also accommodate the apparent indirect effects of intra-functional and cross-functional cooperation.

Finally, covariation between communication variables and competence may not necessarily result from learning. One may for example argue that extent of communication and intraorganizational competence are both related to organization-wide social networks. It can also be argued that extent of communication partly depends on the employee's knowledge about other employees and knowledge about the organization. An employee with extensive knowledge about persons, activities and resources in different parts of the organization, will have a greater tendency to engage in information exchange within the organization. Combined with actual interpersonal relations, communication may become extensive as well as effective. This may in turn boost the employee's competences. We may in other words assume reciprocal relationships between communication and intraorganizational/intraunit competence. These arguments do not, however, apply to firm specific technical competence.

There are no strong reasons to believe that technical competence gives rise to communication. We might speculate that a highly competent employee is frequently asked for help and advice from a number of less competent employees (Blau, 1963). Measures of communication include one item about being asked for or giving help or advice and one item about receiving help or advice. Firm specific technical competence correlates at 0.24 (cross-unit) and 0.18 (within unit) with *giving* advice, whereas with *receiving* advice correlations are 0.14 (cross-unit) and 0.01 (within unit). These results suggest that specific communication activities (notably giving advice) may be affected by the employee's initial level of competence or the employee's reputation. However, the regression results change only slightly if the two items about advice are excluded. Although some of the communication measures may be involved in a different causal process, I maintain that a learning process basically relates communication and technical competence.

Cohort effects

This study included time with the company and time in the unit as determinants of competence acquisition. I did in particular analyze the functional form of the relation between time (years) and competence level in order to test the assumption that the rate of learning will decrease with time and, eventually, plateau (Proposition 2). This is consistent with previous research assuming that the relation between time and competence is monoton. In a cross-sectional study, it is assumed that differences among individuals measured at one point in time correspond to changes occurring across time for individuals.

Regression analyses of the relation between organizational tenure (number of years) and intraorganizational competence showed that competence increases at a decreasing rate (as predicted) and eventually plateaus between 6 and 10 years. More detailed analyses on shorter intervals of tenure did, however, reveal marked variations between 10 and 25 years of tenure. From 14 to 18 years and from 19 to 25 years there are statistically significant *decreases* in competence level. Extensive smoothing (5 and 7 year intervals) did not remove the overall impression of waves lasting 4-5 years. I detected the same pattern, although not statistically significant, for firm-specific technical competences.

There is no obvious explanation for this anomaly. Few previous studies have reported similar result. Spiker and associates (1985) recorded task speed and accuracy among automotive mechanics as a function of task experience. The mechanics' performance increased at a decreasing rate but peaked at and then declined from an intermediate level of experience. The most experienced mechanics made more errors and worked slower than mechanics at an intermediate level of experience. Spiker and associates hypothesized that carelessness, forgetting, lack of motivation, false confidence or some combination of these factors caused the observed decline. In a study of baseball batter performance, Hofmann and associates (1992) found an increase until 5 years of practice and then a performance decline after 5 years, but did not provide a specific explanation for this unexpected pattern.

In the present study, no objective measures of competence or performance were used, hence, learning curve anomalies can not be due to carelessnes or false confidence in task

completion. We may however speculate that motivation to keep up to date is falling through the career or that a certain carelessness with regard to learning occurs during the career. In addition, these factors can hardly account for the wave-like shape of the curve.

Statoil was established in 1972 and a small number of persons were recruited the following year. The range of tenures included in the present sample is 0-25 years (mean and median at about 12 years). This means that half of my sample was recruited during Statoil's growth from its founding in 1972 to full operations around 1987. During this period, Statoil has grown from employing one single employee to employing around 17000, the company's operations have shifted into new geographical areas (north of 62° northern, international), gas is gaining a larger share of the resource portfolio, and the organization has been restructured a number of times. This can affect the relation between tenure and competence outcomes in a number of ways.

Persons who were recruited during a period of organizational foundation, construction and growth may have had a learning *advantage* compared to those recruited during stable periods. Learning advantages may stem from better opportunities to obtain more intimate knowledge of the organizational culture and politics. Rather than being thrown into a large, well-established organization, these veterans have had the opportunity to learn about new coworkers as they were recruited and socialized, and to learn about personal relations as they developed. A large number of these veterans hold key positions in the organization and are probably connected to large, organization-wide informal networks. These veterans may have been personally involved in organizational design and establishment of routines. In addition, during the early and expansive phases of an organization's life, tasks, jobs and structures may not be well defined and there may be critical periods of manpower shortage. During such periods, veterans may thus have been forced to accept tasks across a number of domains and to solve unexpected problems. Under these specific circumstances, learning plateaus may not be observed in cross-sectional data.

Veterans may also have a learning *disadvantage* compared to relative newcomers. Organizational and technological changes entail substantial learning for the employees involved. Up-to-date-competences must replace competences related to outdated

equipment, work processes and structures. To the degree that unlearning must take place before new competences are effective, newcomers may have an advantage compared to veterans. In cross-sectional data, this may be observed as maximum competence at intermediate levels of tenure.

We should also note that diminishing and asymptotic relations between tenure and competence is based on an assumption of relatively stable environments. Frequent changes in the organization, the technology and the operating environment require constant learning and plateauing may not be observed.

Finally, we can also imagine that such changes may also be the situation with large amounts of novel information and thus a high rate of learning. If the organizational history is characterized by relative stability punctuated by periods of relatively substantial changes, the time of entry into the organization may be crucial for the employee's rate of learning. Statoil's history is marked with a number of such notable changes, for example the incorporation of Mobil's Statfjord field organization (including three large oil platforms and 2000 employees).

Taken together, these mechanisms may have affected my data in incomprehensible ways. These statistical patterns may result from the cohort effects outlined above.

6.2.3 MEASUREMENT

Outcome variables

Earlier I suggested that the consistently and substantially lower multiple correlation coefficient (R^2) for task specific competence is related to the selection of explanatory variables. Variation in the dependent variable not captured by included variables may be ascribed to unobserved and unknown variables (provided that these unobserved variables are not perfectly related to the set of included variables). There is also some degree of random variation in the dependent variables, for example choice of response category 3 or 4 is a chance event if the respondent believes that he or she is somewhere in between. It can be argued that a smaller proportion of variation accounted for is related to a larger proportion of random measurement error associated with the

dependent variable. Whereas intra-organizational and intra-unit competences are related to the same or similar domains (respectively) for all employees in the survey, firm specific technical competences are related to domains with highly different characteristics. Questions may have different meanings or be interpreted differently by employees within different occupations. Questionnaire responses related to task specific domains ("field of practice") might thus involve a larger random error than responses related to general domains. This will in turn produce a larger proportion of unexplained variance in the dependent variable. Because the data analysis cannot separate properly between variation due to unobserved variables and random measurement error, the possibility that the low R^2 for firm specific technical competence is related to more random measurement error than for the other outcomes remains to be investigated in future research.

Previous research on abilities, competences and performance has been concerned with the validity of self-report measures for such variables. It has been suggested that specific measurement formats may be applied in order to increase the accuracy of self-reports (Mabe & West, 1982): The use of social comparison terminology (such as "as compared to your fellow workers"), expectation of validation of self-reports, and promises of anonymity. I implemented the comparison format in a small number of items. Respondents in the present study did not welcome social comparison, as I suggested earlier, this could be attributed to the stronger egalitarian norms in Norway as compared to the USA where Mabe and West's data was collected. The majority of respondents authorized a third-party validation of self-reports. Beyond this, no effort was made to compare ratings to an external criterion.

Although accuracy of competence ratings is desirable, its importance and impact in the context of hypothesis testing may not be critical. Let us consider three different forms of measurement error inherent in competence self-rating. First, if respondents are generally uninformed about their own competence level, responses will sometimes be too high and sometimes too low, and random error will increase. A large proportion of random error will only affect the probability that a true non-zero relation between variables is identified. Second, if respondents consistently and uniformly overrate their own competences (as we can reasonably expect), the average level will be biased but each

respondent's level with regard to this average will not. This should imply that neither estimates of relations among variables are affected nor the uncertainty associated with these estimates.

Third, if respondents' propensity to bias responses in a specific direction covaries with other variables of interest, relations with explanatory variables may be obscured or inflated. In order to control for this third case, I included two questionnaire items intended to measure the respondent's general belief in his or her own ability to accomplish tasks (self-confidence or general self-efficacy beliefs). This variable should indicate the respondent's tendency to overestimate or underestimate her or his competences. Data analysis revealed that this measure correlates moderately (around 0.15) with outcomes and modestly with explanatory variables (-0.1 to 0.05). Multiple regression coefficients were not affected when this variable was included. There does however appear to be one interaction with self-confidence: there is no relation between job transitions and intraorganizational/firm-specific technical competence for employees below the median score on self-confidence.

Explanatory variables

The present analyses demonstrate that work-team participation is not associated with outcomes, whereas the extent of cross-functional cooperation is somewhat related to learning outcomes. This suggests that teamwork is a blunt measure of exposure or that respondents did not discriminate properly between team and task force. We further note that affiliation with a professional lateral relation does not affect intraorganizational and firm specific technical competences as expected, whereas, surprisingly, there is a positive association with intraunit competence. Teamwork and lateral relation are both categorical variables. The findings for continuous variables demonstrate that the strongest effect occurs at the lowest levels of exposure, the effect then rapidly decreases and disappears at a learning plateau. The question may be raised as to whether categorical variables may be too coarse to capture these nuances.

6.3 Implications for practice

Implications for managers and employers

Human Resource Management

There are three ways in which the present findings are relevant to human resource management (HRM).

First, managers concerned with employee development should be aware of the effects of different employee experiences on employee competences. Competences are to a varying degree affected by career history, organizational structures and communication. Employers can at best manage communication patterns of individual employees indirectly, whereas career patterns and assignment of employees to permanent and temporary structures are at the discretion of managers. Employers may affect individual communication by assigning employees to tasks, projects, jobs, departments and physical environments that are likely to give rise to the desired type of communication. With regard to the independent variables included in this study, the greatest predictive information appears to be related to non-task specific competences. Thus, the implications I suggest here mainly concern intra-organizational and intra-unit competence.

Employee transfers may serve multiple purposes by filling vacancies, developing desired competences, transferring competences between different parts of the organization, offering greater task variety and job satisfaction, and establishing personal relations across unit boundaries. The indirect effect of a single transfer may thus persist through communicative links to other parts of the organization. Managers have acknowledged the direct effect on competence and have incorporated this into various types of trainee and rotation programs. Planned transfers could, however, successfully be extended to larger groups of employees. Organizational structures do have the anticipated direct effect on competences. Employers may assign employees to tasks, projects, cross-unit relations and physical environments that are likely to give rise to the type of communication which in turn gives rise to the desired type of competence.

Second, managers responsible for personnel selection (recruitment, placement, and promotion) may use type of exposure as a *proxy* for type of competence. Competences per se are difficult to measure. Types of experience thus suggest which competences the employee most likely has developed. An above average number of transfers, for example, indicate that the employee has an above average level of intra-organizational competence. This employee should thus be suited for jobs where intra-organizational competence is particularly important.

Finally, this research appears to claim that more is always better. There are however costs as well as benefits associated with learning. Costs are usually linear with respect to consumption of time and other resources, whereas marginal benefit (rate of learning) is diminishing. In most cases, learning is merely a by-product of other activities. If however the main purpose is learning, costs will eventually be larger than the value of learning outputs. Excessive communication in specific directions, for instance, will in this respect be a waste. Trainee and other programs should in particular consider the optimal (as opposed to a maximum) level of competence. The functional form of the relations between inputs and outputs of learning suggest the level at which each unit of input is associated with an insubstantial increase in competence.

Corporate strategy

The present findings may in addition be relevant for corporate strategy. Competence transfer and knowledge sharing is probably the most important economy of scope (Markides & Williamson, 1996; Prahalad & Hamel, 1990). In multidivisional companies, divisions are often governed as if they were independent, profit-seeking companies. This governance form provides powerful result-maximizing incentives and financial control. These advantages are, however, often achieved by sacrificing potential synergies (Altenborg, 1998). The results of this study identify a number of means through which such synergies can be achieved. Cross-divisional task forces or project groups, for example, may be effective mechanisms for bringing people from separate parts of the organization together. Despite counterintuitive effects of lateral relations, corporate wide *personal* networks among employees again seem to be the most powerful mechanism for competence transfer. Managers concerned with corporate

synergies, should thus implement policies that involve cooperation and encourage contact across divisional boundaries.

Implications for employees

Like managers, employees should be aware of the relations between information exposure (as measured by transfers, communication and so forth) and competence development. Depending on the type of intra-organizational career (i.e., managerial vs. professional) the employee pursues, the employee should seek the types of exposure that are most likely to enhance competences that are relevant for that type of career. Individual employees can to some extent manage all the three categories of factors.

An individual employee may apply for jobs in different units or at corporate headquarters in order to increase his or her intra-organizational competence. However, these competence advantages come at the risk of reduced visibility to supervisors. Similarly, turning down offers or refusing assignments may have adverse effects on supervisor goodwill. These issues are in particular critical to expatriate employees for whom a nomadic life may involve adverse career development despite learning advantages.

Employees may not affect organizational structures directly. They may, however, volunteer for taskforces, projects and lateral relations. Involvement in formal cross-unit relations may be an effective strategy for developing corporate wide personal networks. Unlike managers, employees can to a large degree control personal relations and actual communication patterns. According to the present results, communication activities have the largest impact on competences.

6.4 Further research

The substantial and methodological findings presented here suggest a number of lessons and challenges for future research. Some of these issues were also suggested in the preceding sections. In this section I focus on methodology, scope of explanatory and outcome variables, effects of competences on job performance, and explanatory mechanism.

Methodology

I believe that this study has a number of methodological strengths that could benefit future research. The complete model includes eleven explanatory variables, nine of which were measured with a single questionnaire item. About half of the variables are simple factual issues, whereas the others are judgmental. Despite these relatively simple data, I was able to test relatively complex hypotheses and to account for a substantial proportion of variation in the dependent variables. This implies that (given a careful selection of factual measures) valuable data can be collected with relatively short questionnaires. Depending on the type of outcome variables, all relevant data can possibly be obtained from computerized archives. I would further claim that factual and judgmental measures should not be affected by the respondents' tendency to answer all questions in a specific direction or attempts to be consistent. Thus, covariation should not be inflated by the measurement procedures. In addition, no measurement errors should in principle be associated with purely factual questions. Finally, the measurements of competence outcomes that were developed and applied in this study appear to function in a satisfactory way. These measures should, at least, be a fruitful point of departure for future empirical research on competences in work organizations.

There are in particular three areas where future research can potentially achieve methodological improvements. First, there is the issue of internal validity. The design of this study raises questions about the causal direction (temporal order) between variables, for example the relation between technical competence and task force participation. A panel study involving repeated measures of relevant variables across time could possibly determine the actual causal order of these variables. More important, however, is the possible effect of unobserved variables. In field studies, spuriousity can not be ruled out. A more homogenous sample with regard to respondents could possibly reduce the systematic influence of unobserved variables as well as random variation in the outcome variables. Second, there is the validity of competence self-rating. Previous research has invested much effort into assessing and improving self-rating of performance as well as developing alternatives (notably supervisor and peer rating). Although this study did not detect any critical deficiencies with self-rating, future research may benefit from a more elaborate measurement strategy. Third party rating is

a feasible although complex measurement procedure. Future research may alternatively explore other external criteria of validity that do not require third party rating. Finally, external validity of specific findings can be assessed by conducting comparable studies in different firms and industries.

Scope of variables

This study explored three specific competence outcomes derived from Nordhaug's (1993) typology. Further research should extend the scope of outcomes studied. General competences, a large and compound category of competences, in particular needs further conceptual and empirical exploration. With regard to this typology, a further clarification of concepts such as task, occupation and profession may also be needed.

The scope of explanatory variables included should also be extended. We noted that the proportion of variance (as measured by the multiple regression R^2) accounted for by the included independent variables is consistently and substantially smaller for firm specific technical competence than for intra-organizational and intra-unit competence. This clearly indicates that task-specific competences are mainly affected by variables not included in the present study, which in turn suggests that task specific competences are affected by a different set of variables than non-task-specific competences. Future research should thus explore relations among task-specific competence and characteristics of the employee's task and organizational information related to that task. Further research is needed to identify these variables.

Performance effects of competences

The research model may be extended by focusing on the effects of specific competences as well as competence portfolios. These effects can be pursued at several levels. At the individual level, career outcomes, such as promotions and wages, are relevant. At the level of individual-job relation, job performance as well as satisfaction, motivation and work-related behavior are relevant outcome variables. According to the present study and recent research on individual performance, multiple performance measures should be applied in order to capture more aspects of performance as well as possible

differential relations between competences and performance domains. Extra-task performance domains (Motowidlo & Scotter, 1994) are merely proxies for the effects an individual employee has on other employees or on the organization as a whole, for example in terms of motivation and coordination.

The effects of employee competences on the performance of teams and units may also prove a fruitful area of research. Complex conceptual and methodological problems are, however, involved in this type of cross-level models. The performance of work groups may, for example, be affected by the average level and dispersion of a specific competence as well as the multitude of competence types in the group. Recently, we have also witnessed an accelerating interest in the resource-based view of the firm. According to this view, firm competitiveness is related to idiosyncratic resources, notably competences, possessed by the firm. Such resources are usually assumed rather than measured, but again relating employee competences to firm competitiveness may involve additional complexities.

Explanatory mechanisms

The point of departure for this study was the proposition that learning results from the information that the employee has been exposed to. In particular, I studied the effect of accumulated exposure to information in different domains. This conception of learning encompasses a number of unobserved processes, and there is a relatively long causal chain from crude measures of information domains to specific survey measures of competence. Beyond approximate identifications of domains, no effort was made to capture additional complexities of learning such as the integration of pieces of information. At a more detailed level of investigation, several sub-categories of learning mechanisms may be outlined. Future research may for example focus on learning about causal relations and how this differs from learning about facts.

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APPENDICES

APPENDIX A

1. Noen bakgrunnsopplysninger

Du kan bruke standard forkortelse der det er aktuelt.

Hvilket resultatområde (RO) eller hvilken konsernstab er du ansatt i nå?	011
Hvilken resultatenhet (RE) eller tilsvarende er du ansatt i nå?	012
Hvilket funksjonsnettverk er du eventuelt knyttet til?	441

Hvor mange fagnettverk er du eventuelt knyttet til?	Antall:	431
Hvor mange problemløsnings- eller prosjektgrupper på tvers av enheter har du vært med i de siste to årene?	Antall:	421
Hvor mange arbeidsgrupper er du med i for tiden?	Antall:	411
Hvor lenge har du arbeidet i Statoil (alt medregnet)?	År:	301
Hvor mange ganger har du skiftet jobb innenfor Statoil?	Antall:	311
Hvor mange av disse jobbskiftene var eventuelt mellom ulike RO (eller det som tilsvarer dagens RO), mellom ulike konsernstaber eller mellom en konsernstab og et RO?	Antall:	312
Hvor mange av disse jobbskiftene var eventuelt mellom ulike RE (eller tilsvarende)?	Antall:	313
Hvor lenge er det siden du begynte i det RO (eller tilsvarende) eller den konsernstaben du er nå?	År:	314
Hvor lenge er det siden du begynte i det RE (eller tilsvarende) du er nå?	År:	315

Hvordan vil du karakterisere din nåværende stilling? 013

❑ leder ❑ senior fagstilling ❑ annen fagstilling ❑ sekretær, betjent ❑ operatør, tekniker

Dersom du er leder, hvilket nivå er du leder på? 014

❑ RO el. konsernstab ❑ RE el.tilsv. ❑ Sektor ❑ Avdeling ❑ Seksjon el. lavere

Hva er hovedinnholdet i den jobben du har nå? 015

❑ Ingeniørfag el. annet teknisk arbeid ❑ Økonomi/administrasjon ❑ Annet

Alder: 001	❑ Kvinne ❑ Mann	002
Din viktigste gradgivende utdanning (tittel, fagområde og lengde)	Tittel:	041
Fagområde: 042	Lengde (år):	043

I resten av spørreskjemaet er svarene angitt med små avkrysningsruter (☐), hvor svarene skal scannes (leses av datamaskin). Bruk derfor mørk kulepenn og fyll ut mest mulig av området inne i den ruten du velger, omtrent slik: ■

2. Om enheten

I denne delen ber vi om din vurdering av arbeidsmåter og andre forhold innen din enhet. Med "din enhet" mener vi det *resultatområdet* (RO) eventuelt den *konsernstaben* eller *konsernenheten* du er ansatt i nå. **Unntatt** fra dette er *Drift olje (DRO), Gass produksjon & transport (GPT) og Teknologi, produkter & kompetanse (TPK)* der vi med "enhet" mener *resultatenhet* (RE). Er du f.eks. ansatt på Gullfaks skal du tenke på Gullfaks når vi spør om "din enhet", og er du ansatt i Boring & brønn (B&B) under resultatområdet TPK skal du tenke på B&B når vi spør om "din enhet". Dersom du er midlertidig utlånt til en annen enhet, skal du tenke på den enheten der du har din faste tilknytning.

2.1 Først noen påstander om forholdet til den enheten du er ansatt i nå. Angi hvor godt påstandene stemmer for deg ved å velge et alternativ fra 1 (helt uenig) til 5 (helt enig).

	Helt uenig	Delvis uenig	Hverken enig eller uenig	Delvis enig	Helt enig
Jeg har god oversikt over hva andre avdelinger i min enhet driver med.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Jeg gjør ofte en ekstra innsats for å hjelpe kollegaer i enheten min.	☐	☐	☐	☐	☐
Sammenliknet med de fleste av mine kollegaer har jeg god kunnskap om hvordan min enhet er organisert.	☐	☐	☐	☐	☐
Jeg behersker de rutinene som gjelder i min enhet.	☐	☐	☐	☐	☐
Jeg gir ofte råd, støtte og hjelp til kollegaer i min egen enhet utover de krav som jobben setter.	☐	☐	☐	☐	☐
Sammenliknet med mine kollegaer har jeg god kjennskap til hvordan det er mulig å påvirke viktige beslutninger i min enhet.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Jeg føler svært stor lojalitet til denne enheten.	☐	☐	☐	☐	☐
Jeg har god kjennskap til enhetens historie, mål og strategi.	☐	☐	☐	☐	☐
Overfor kollegaer i Statoil omtaler jeg min enhet som en bra enhet å arbeide for.	☐	☐	☐	☐	☐
Jeg vet hvem jeg kan kontakte innenfor min enhet for å få hjelp til å løse problemer som måtte oppstå.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Dersom jeg kunne få en like god jobb som den jeg har nå, i en annen enhet i Statoil, ville jeg skifte jobb.	☐	☐	☐	☐	☐
Jeg er stolt av å arbeide for denne enheten.	☐	☐	☐	☐	☐
Denne enheten inspirerer meg til å yte mitt beste.	☐	☐	☐	☐	☐
Jeg føler meg mer knyttet til enheten min enn til Statoil.	☐	☐	☐	☐	☐

2.2 De nesten spørsmålene omhandler arbeidsmåter innen enheten. Velg det alternativet som passer best for ditt vedkommende.

Hvor stor del av en vanlig arbeidsdag arbeider du sammen med andre som utfører liknende oppgaver?	aldri ☐	under 30 min ☐	½-2 timer ☐	2-4 timer ☐	4-6 timer ☐	over 6 timer ☐
Hvor stor del av en vanlig arbeidsdag arbeider du sammen med andre som utfører oppgaver ulikt dine egne?	aldri ☐	under 30 min ☐	½-2 timer ☐	2-4 timer ☐	4-6 timer ☐	over 6 timer ☐
I løpet av den siste arbeidsuken, hvor ofte diskuterte du fag med personer i din egen enhet?	aldri ☐	1 gang ☐	ca 1-3 ganger ☐	hver dag ☐	flere ganger for dag ☐	minst hver time ☐
Hvor ofte diskuterte du konkrete arbeidsoppgaver med enkeltpersoner i din egen enhet i løpet av den siste arbeidsuken?	aldri ☐	1 gang ☐	ca 1-3 ganger ☐	hver dag ☐	flere ganger for dag ☐	minst hver time ☐
Hvor mange ganger ble du spurt om råd eller hjelp fra personer idin egen enhet i løpet av den siste arbeidsuken?	aldri ☐	1 gang ☐	ca 1-3 ganger ☐	hver dag ☐	flere ganger for dag ☐	minst hver time ☐
Hvor ofte i løpet av de siste 3 månedene mottok du skriftlige rapporter eller notater fra personer i din egen enhet?	aldri ☐	1-3 ganger ☐	minst 1 gang hver mnd ☐	minst 1 gang hver uke ☐	ca 1-4 ganger hver uke ☐	minst hver dag ☐
Hvor mange ganger i løpet av den siste arbeidsuken fikk du råd eller hjelp fra personer i din egen enhet?	aldri ☐	1 gang ☐	ca 1-3 ganger ☐	hver dag ☐	flere ganger for dagen ☐	minst hver time ☐
Hvor ofte deltok du i problemløsningsmøter eller liknende med to eller flere personer i din egen enhet i løpet av de siste 3 månedene?	aldri ☐	1-3 ganger ☐	1-3 ganger hver mnd ☐	hver uke ☐	1-4 ganger hver uke ☐	hver dag eller oftere ☐

3. Om Statoil som helhet

3.1 Nedenfor finner du en del påstander om ditt forhold til Statoil som helhet. Angi hvor godt utsagnet stemmer for deg ved å velg et alternativ mellom 1 (helt uenig) og 5 (helt enig).

	Helt uenig	Delvis uenig	Hverken enig eller uenig	Delvis enig	Helt enig
Jeg har god oversikt over hva andre enheter i Statoil driver med.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Sammenliknet med mine kollegaer har jeg god kjennskap til hvordan Statoil er organisert.	☐	☐	☐	☐	☐
Jeg gjør ofte en ekstra innsats for å hjelpe Statoil.	☐	☐	☐	☐	☐
Jeg behersker de rutinene som gjelder i Statoil.	☐	☐	☐	☐	☐
Sammenliknet med de fleste av mine kollegaer har jeg har god kjennskap til hvordan det er mulig å påvirke viktige beslutninger i Statoil.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Jeg har god kjennskap til Statoils historie, mål og strategi.	☐	☐	☐	☐	☐
Noen av de arbeidsoppgavene jeg er tildelt blir forsømt.	☐	☐	☐	☐	☐
Jeg vet hvem jeg kan kontakte innenfor Statoil for å få hjelp til å løse problemer som måtte oppstå.	☐	☐	☐	☐	☐
Dersom jeg kunne få en like god jobb som den jeg har nå, hos en annen arbeidsgiver på hjemstedet, ville jeg skifte jobb.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Jeg er stolt av å arbeide for Statoil.	☐	☐	☐	☐	☐
Jeg føler svært stor lojalitet til Statoil.	☐	☐	☐	☐	☐
Overfor venner omtaler jeg Statoil som en god organisasjon å arbeide for.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Statoil inspirerer meg til å yte mitt beste.	☐	☐	☐	☐	☐
Jeg føler meg mer knyttet til min egen yrkeskarriere enn til Statoil.	☐	☐	☐	☐	☐
Jeg tar frivillig på meg oppgaver jeg formelt sett ikke er tildelt.	☐	☐	☐	☐	☐

3.2 De neste spørsmålene gjelder arbeidsmåter i forhold til andre enheter innenfor Statoil. Velg det alternativet som passer best for ditt vedkommende.

	aldri	1 gang	ca 2-3 ganger	ca 2-4 ganger pr mnd	ca 1-5 ganger hver uke	minst hver dag
I løpet av de siste 3 månedene, hvor ofte diskuterte du fag med kolleger i andre enheter?	☐	☐	☐	☐	☐	☐
Hvor ofte diskuterte du konkrete arbeidsoppgaver med medarbeidere i andre enheter i løpet av de siste 3 månedene?	☐	☐	☐	☐	☐	☐
Hvor mange ganger ble du spurt om råd eller hjelp fra personer i andre enheter i løpet av de siste 3 månedene?	☐	☐	☐	☐	☐	☐
Hvor ofte i løpet av de siste 3 månedene mottok du rapporter eller notater fra personer i andre enheter?	☐	☐	☐	☐	☐	☐
Hvor mange ganger i løpet av de siste 3 månedene fikk du råd eller hjelp fra personer i andre enheter?	☐	☐	☐	☐	☐	☐
I løpet av de siste 3 månedene, hvor ofte deltok du i problemløsningsmøter eller liknende med 2 eller flere personer fra andre enheter?	☐	☐	☐	☐	☐	☐

	Helt uenig	Delvis uenig	Hverken enig eller uenig	Delvis enig	Helt enig
Jeg gir ofte råd, støtte og hjelp til kollegaer i andre enheter utover de krav jobben min setter.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Jeg gjør ofte en ekstra innsats for å hjelpe kollegaer i andre enheter.	☐	☐	☐	☐	☐

3.3 Nedenfor finner du noen spørsmål om arbeidsmåter i funksjons- og fagnettverk. Dersom du ikke er tilknyttet funksjons- eller fagnettverk skal du hoppe over disse spørsmålene.

I løpet av de siste 2 årene, omtrent hvor mange ganger deltok du i møter arrangert av ditt eget *funksjonsnettverk*?	aldri ☐	1 gang ☐	ca 2-3 ganger ☐	2-4 ganger hvert år ☐	5-8 ganger hvert år ☐	ca hver mnd ☐
Hvor lenge er det siden sist du deltok i et møte med ditt eget *funksjonsnettverk*?	aldri ☐	minst 1 år ☐	ca 6-12 mnd ☐	ca 3-6 mnd ☐	ca 1-3 mnd ☐	under 1 mnd ☐
Hvor mange ganger i løpet av de siste 2 årene deltok du i møter arrangert av et *fagnettverk*?	aldri ☐	1 gang ☐	ca 2-3 ganger ☐	2-4 ganger hvert år ☐	5-8 ganger hvert år ☐	ca hver mnd ☐
I løpet av det siste året, hvor mange ganger var du i kontakt med leder for funksjonsnettverket?	aldri ☐	1 gang ☐	ca 2-4 ganger ☐	ca annen-hver mnd ☐	ca hver mnd ☐	flere ganger hver mnd ☐

4. Om faget ditt

Nedenfor følger noe påstander om det *faget* du arbeider i nå. Med fag mener vi her det fagområde eller fagfelt det er mest naturlig å si at din jobb hører til. Dersom du er leder, skal du tenke på det fagfeltet du er leder for. Dersom det likevel er vanskelig å si hvilket fag du jobber i, kan du eventuelt ta utgangspunkt i de faglige kvalifikasjoner som normalt kreves for den jobben du har nå. Ta stilling til hver av disse påstandene ved å velge et alternativ fra 1 (helt uenig) til 5 (helt enig).

4.1 Først litt om ditt fag innenfor Statoil.

	Helt uenig	Delvis uenig	Hverken enig eller uenig	Delvis enig	Helt enig
Sammenliknet med mine kollegaer har jeg god kjennskap til hvordan tilsvarende oppgaver blir utført andre steder i Statoil.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Jeg mangler en del kunnskap om spesielle forhold Statoil arbeider under.	☐	☐	☐	☐	☐
Ingenting er umulig bare jeg virkelig går inn for det.	☐	☐	☐	☐	☐
Jeg mangler en del kunnskap om hvordan jeg skal bruke teknisk utstyr som er spesielt for Statoil.	☐	☐	☐	☐	☐
Jeg behersker de arbeidsmåtene som brukes i mitt fag innen Statoil.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Dersom jeg kunne få en like god jobb som den jeg har nå, innen et annet fag i Statoil, ville jeg skifte fag.	☐	☐	☐	☐	☐
Jeg har god kjennskap til den siste utviklingen innen mitt fag i Statoil.	☐	☐	☐	☐	☐
Sammenliknet med de fleste av mine kollegaer har jeg svært god kjennskap til Statoils viktigste utfordringer innen mitt fag.	☐	☐	☐	☐	☐
Jeg gir ofte opp før ting er fullført.	☐	☐	☐	☐	☐
Når bekjente spør hva jeg arbeider med, legger jeg mest vekt på faget og mindre vekt på at jeg arbeider i Statoil.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Sammenliknet med mine kollegaer har jeg har god kunnskap om de erfaringene Statoil har gjort seg innen mitt fag.	☐	☐	☐	☐	☐
Jeg har svært god kjennskap til Statoils standarder innen mitt fag.	☐	☐	☐	☐	☐

4.2 De neste påstandene gjelder faget ditt mer generelt.

	Helt uenig	Delvis uenig	Hverken enig eller uenig	Delvis enig	Helt enig
Sammenliknet med de fleste av mine fagkollegaer har jeg god kompetanse til å utføre de oppgavene jeg er tildelt.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Jeg har god oversikt over alternative løsninger på de fleste faglige utfordringene innen mitt fag.	☐	☐	☐	☐	☐
Jeg mangler en del kunnskap om hvordan jeg skal bruke teknisk utstyr som er spesielt for mitt fag.	☐	☐	☐	☐	☐
Sammenliknet med mine fagkollegaer kjenner jeg mitt eget fag godt.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Jeg har god kjennskap til den siste utviklingen i faget.	☐	☐	☐	☐	☐
Sammenliknet med det fleste av mine fagkollegaer har jeg har svært god kjennskap til de viktigste problemstillingene i faget.	☐	☐	☐	☐	☐
Sammenliknet med mine fagkollegaer har jeg svært god kjennskap til aktuelle tekniske standarder i oljebransjen.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Jeg er stolt av å arbeide i dette faget.	☐	☐	☐	☐	☐
Jeg føler svært stor lojalitet til mitt fag.	☐	☐	☐	☐	☐
Jeg føler meg mer knyttet til min egen yrkeskarriere enn til faget.	☐	☐	☐	☐	☐
Overfor venner omtaler jeg mitt fag som et godt fag å arbeide i.	☐	☐	☐	☐	☐
Faget mitt inspirerer meg til å yte mitt beste.	☐	☐	☐	☐	☐

5. Om jobben din i Statoil

5.1 Nedenfor følger noen påstander om Statoil og jobben din. Angi hvor godt hver av påstandene stemmer ved å velge ett alternativ mellom 1 (helt uenig) og 5 (helt enig).

	Helt uenig	Delvis uenig	Hverken enig eller uenig	Delvis enig	Helt enig
For å kunne gjøre en god jobb i Statoil har det vært nødvendig å sette seg inn i spesielle rutiner, organisasjonsform, Statoils historie og andre spesielle forhold ved Statoils organisasjon.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Det er gode muligheter til å gjøre karriere i Statoil.	☐	☐	☐	☐	☐
For å kunne gjøre en god jobb i Statoil har det vært nødvendig å sette seg inn i spesielle standarder, teknisk utstyr eller andre tekniske forhold som i liten grad finnes i andre bedrifter.	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Besultatvurderingen i forbindelse med medarbeidersamtale/MLP har stor betydning for min videre karriere i Statoil.	☐	☐	☐	☐	☐
For å kunne gjøre en god jobb i min enhet har det vært nødvendig å sette seg inn i spesielle rutiner, organisering og andre spesielle forhold ved *enheten.*	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
Utdanningen min er spesielt innrettet mot oljebransjen.	☐	☐	☐	☐	☐

5.2 Nedenfor følger noen spørsmål om den jobben du har i Statoil. Les spørsmålet nøye og velg et alternativ mellom 0-4 uker (inntil en måned) og 2 år eller mer.

	0 - 4 uker	1 - 3 mnd	3 - 6 mnd	6 - 12 mnd	1 - 2 år	2 år eller mer
Tenk deg en person med like lang erfaring fra oljebransjen som deg selv, *men fra andre typer jobber og med en annen utdanning.* Omtrent hvor lang tid ville det ta å lære opp vedkommende til å utføre den type jobb du har?	☐	☐	☐	☐	☐	☐
Tenk deg en person med samme utdanning og tilsvarende jobb som deg *i et annet oljeselskap.* Omtrent hvor lang tid ville det ta å lære opp vedkommende til utføre jobben din *i Statoil?*	☐	☐	☐	☐	☐	☐
Tenk deg en person *med omtrent samme utdanning og jobb som deg i en annen enhet i Statoil.* Omtrent hvor lang tid ville det ta å lære opp vedkommende til å utføre den jobben du har nå?	☐	☐	☐	☐	☐	☐

APPENDIX B

Questionnaire item respons and non-respons

#	Item	Response	Non-response	%
1	Age (years)	963	18	1.8
2	Gender	977	4	0.4 ***
11	In which business area or in which corporate staff are you currently employed?	977	4	0.4 ***
12	In which profit unit are you currently employed?	963	18	1.8
13	How would you characterize your current job in Statoil?	979	2	0.2 ***
15	How would you characterize the content of your current job in Statoil?	979	2	0.2 ***
21	I give up on things before completing them.	963	18	1.8
22	Nothing is impossible if I am really putting in effort.	963	18	1.8
41	Your main education	957	24	2.4 *
43	Years of education (related to item 41)	941	40	4.1 ***
231	I am well informed about the activities of other Statoil units.	964	17	1.7
232	Compared to my fellow workers, I have extensive knowledge about Statoil's organizational structure.	965	16	1.6
234	I have a good command of the routines in Statoil.	962	19	1.9
235	Compared to most of my colleagues, I know how to influence important decisions in Statoil.	962	19	1.9
236	I have extensive knowledge of Statoil's strategy, objectives and history.	967	14	1.4
237	I know whom to ask for help within Statoil to solve problems that might occur.	966	15	1.5
241	I am well informed about the activities of other departments in my unit.	965	16	1.6
242	Compared to most of my colleagues, I have an extensive knowledge of the structure of my unit.	963	18	1.8
243	I have a good command of the routines in my unit.	968	13	1.3
244	Compared to my colleagues, I know how to influence important decisions in my unit.	963	18	1.8
245	I have extensive knowledge of my unit's strategy, objectives and history.	963	18	1.8
246	I know whom to ask for help within my unit to solve problems that might occur.	969	12	1.2
271	Compared to my colleagues, I know very well how similar tasks are performed in other Statoil units.	960	21	2.1
272	I have inadequate knowledge about circumstances specific to Statoil.	951	30	3.1 ***
273	I have inadequate knowledge about how to use Statoil-specific equipment.	960	21	2.1
274	I have good command of working methods within my field within Statoil.	965	16	1.6
275	I have good knowledge of current developments within my field within Statoil.	965	16	1.6
276	Compared to most of the colleagues, I have thorough knowledge of Statoil's main challenges within my field.	964	17	1.7
277	Compared to my colleagues, my knowledge of Statoil's experiences within my field is good.	966	15	1.5

278	I have extensive knowledge of Statoil's standards within my professional field.	962	19	1.9	
301	How many years of work experience within Statoil do you have?	980	1	0.1	***
311	How many times did you change job in Statoil?	979	2	0.2	***
312	How many of these were across divisional borders (or what corresponds to current business area borders), across corporate staff borders or across staff-division borders?	979	2	0.2	***
313	How many of these were across profit unit borders (alternatively corresponding to current profit units)?	975	6	0.6	**
314	How many years have you been with your current business area (or equivalent) or corporate staff?	978	3	0.3	***
315	How many years have you been with your current profit unit (or equivalent)?	974	7	0.7	**
411	How many work groups are you currently involved in?	910	71	7.2	***
421	How many cross-unit task forces or project groups have you been involved in?	930	51	5.2	***
511	During the past 3 months, how often did you have professional exchanges with colleagues in other organizational units?	970	11	1.1	***
512	How often have you and colleagues in other units discussed tasks during the past 3 months?	968	13	1.3	***
513	How often did colleagues in other units ask for your help or advice during the past 3 months?	967	14	1.4	
514	How often during the past 3 months did you receive reports or memos from coworkers in other units?	960	21	2.1	
515	How often during the past 3 months did you receive help or advice from coworkers in other units?	963	18	1.8	
516	During the past 3 months, how often did you participate in problem-solving meetings involving 2 or more coworkers from other units?	965	16	1.6	
531	During the past week, how often did you have professional exchanges with persons in your own unit?	962	19	1.9	
532	How often did you and colleagues in your own unit discuss tasks during the past week?	970	11	1.1	
533	How often did colleagues in your own unit ask for your help or advice during the past week?	971	10	1.0	
534	How often during the past 3 months did you receive written reports or memos from coworkers in your own unit?	964	17	1.7	
535	How often during the last week did you receive help or advice from coworkers in your own unit?	973	8	0.8	*
536	How often did you participate in problem-solving meetings involving 2 or more coworkers from your own unit during the past 3 months?	969	12	1.2	
541	During a normal day at work, how much time do you spend working together with others with similar tasks?	967	14	1.4	*
542	During a normal day at work, how much time do you spend working together with others with tasks different from your own?	966	15	1.5	
	Average		17.5	1.8	
	Chi-square test for equality of respons rates		Chi-sq	1.05	n.s.

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

APPENDIX C

Factor analysis of communication[a]

Item #		Other units	Same unit
531	During the past week, how often did you have professional exchanges with persons in your own unit?	-0,077	**0,816**
532	How often did you and colleagues in your own unit discuss tasks during the past week?	-0,060	**0,874**
533	How often did colleagues in your own unit ask for your help or advice during the past week?	-0,057	**0,790**
534	How often during the past 3 months did you receive written reports or memos from coworkers in your own unit?	0,139	**0,524**
535	How often during the last week did you receive help or advice from coworkers in your own unit?	-0,013	**0,748**
536	How often did you participate in problem-solving meetings involving 2 or more coworkers from your own unit during the past 3 months?	0,116	**0,681**
511	During the past 3 months, how often did you have professional exchanges with colleagues in other organizational units?	**0,830**	0,045
512	How often have you and colleagues in other units discussed tasks during the past 3 months?	**0,891**	-0,060
513	How often did colleagues in other units ask for your help or advice during the past 3 months?	**0,844**	-0,039
514	How often during the past 3 months did you receive reports or memos from coworkers in other units?	**0,756**	0,076
515	How often during the past 3 months did you receive help or advice from coworkers in other units?	**0,839**	0,019
516	During the past 3 months, how often did you participate in problem-solving meetings involving 2 or more coworkers from other units?	**0,825**	-0,015

[a]Non-ortogonal rotation.

APPENDIX D
ASSESSMENT OF FUNCTIONAL FORM

TABLE D.1: *ANOVA assessment of functional form: Cross-unit transfers*

Predicting intra-organizational competence

		SS	df	F	sign
Explained	Total	37.09	11	9.65	0.000
	Linear specification	25.90	1	74.15	0.000
	Deviation[a]	11.19	10	3.20	0.000
	Hyperbolic	33.86	1	96.97	0.000
	Deviation	3.22	10	0.92	0.512
Residual		313.27	897		
Total		350.35	908		

Predicting firm-specific competence

		SS	df	F	sign
Explained	Total	7.72	11	2.03	0.024
	Linear specification	2.08	1	6.00	0.014
	Deviation	5.64	10	1.63	0.094
	Hyperbolic	4.39	1	12.67	0.000
	Deviation	3.33	10	0.96	0.477
Residual		304.00	877		
Total		311.72	888		

[a]Variance (SS) explained in ANOVA, but not by regression.

TABLE D.2: *ANOVA assessment of functional form: Job transitions*

		All respondents				Respondents that never transferred			
		SS	df	F	sign	SS	df	F	sign
		Predicting intra-organizational competence							
Explained	Total	13.6	15	2.40	0.002	6.3	10	0.63	0.069
	Linear	3.9	1	10.20	0.001	1.0	1	1.02	0.093
	Deviation	9.7	14	1.84	0.030	5.3	9	0.59	0.106
	Hyperbolic	5.7	1	15.03	0.000	2.0	1	2.02	0.018
	Deviation	7.9	14	1.49	0.106	4.3	9	0.47	0.225
Residual		335.7	890			117.2	326	0.36	
Total		349.3	905			123.5	336		
		Predicting intra-unit competence							
Explained	Total	9.1	15	1.53	0.087	6.8	10	1.67	0.088
	Linear	4.4	1	11.20	0.001	2.7	1	6.69	0.010
	Deviation	4.7	14	0.84	0.624	4.1	9	1.11	0.357
	Hyperbolic	6.2	1	15.66	0.000	4.4	1	10.61	0.001
	Deviation	2.9	14	0.52	0.921	2.5	9	0.67	0.735
Residual		361.4	913			139.1	339		
Total		370.6	928			145.9	349		

TABLE D.3 ANOVA assessment of functional form: Organizational tenure

		SS	df	F	sign
	Organizational tenure predicting intraorganizational competence				
Explained	Total	50.97	55	2.65	0.000
	Linear specification	16.63	1	47.54	0.000
	Deviation	34.34	54	1.82	0.000
	Hyperbolic	23.71	1	67.80	0.000
	Deviation	27.26	54	1.44	0.022
Residual		300.05	858		
Total		351.02	913		
	Organizational tenure predicting firm specific technical competence				
Explained	total	17.65	56	0.90	0.692
	Linear	0.52	1	1.47	0.226
	Deviation	17.14	55	0.88	0.710
	Hyperbolic	3.13	1	8.88	0.003
	Deviation	14.53	55	0.75	0.910
Residual		294.80	837		
Total		312.45	893		

TABLE D.4 ANOVA assessment of functional form - unit tenure.

		SS	df	F	sign
Predicting intra-unit competence					
Explained	total	46.28	63	1.96	0.000
	Linear specification	2.11	1	5.64	0.018
	Deviation	44.16	62	1.90	0.000
	Hyperbolic specification	10.58	1	28.24	0.000
	Deviation	35.70	62	1.54	0.006
Residual		324.37	866		
Total		370.65	929		

TABLE D.5 ANOVA assessment of functional form - task force participation

		SS	df	F	sign
Predicting intra-organizational competence					
Explained	total	17.97	21	2.33	0.001
	Linear specification	6.80	1	18.52	0.000
	Deviation	11.18	20	1.52	0.066
	Hyperbolic specification	10.30	1	28.07	0.000
	Deviation	7.67	20	1.05	0.404
	Square-root specification	11.33	1	30.89	0.000
	Deviation	6.64	20	0.90	0.581
Residual		310.71	847		
Total		328.68	868		
Predicting firm specific technical competence					
Explained	total	14.63	19	2.28	0.001
	Linear	8.28	1	24.48	0.000
	Deviation	6.35	18	1.04	0.407
	Hyperbolic	6.80	1	20.11	0.000
	Deviation	7.83	18	1.29	0.188
	Square-root specification	9.67	1	28.59	0.000
	Deviation	4.97	18	0.82	0.683
Residual		280.73	830		
Total		295.36	849		