Ove Rustung Hjelmervik

Knowledge-driven value creation

ICT-supported knowledge representation for Development of Routines in industry

Thesis for the degree of philosophiae doctor

Trondheim, February 2007

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Science and Technology
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Department of Production and Quality Engineering

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Acknowledgement

After more than 30 years within the global oil and gas industry it has been a particular experience to complete this PhD program. During the last years of my Statoil period I raised a question related to organizational learning which seemed to attract attention from academia. Many people have contributed to this thesis. Professor Anna Mette Fuglseth, department for Strategy and Management, NHH, brought me inn and supported my engagement in NHH's PhD courses. Furthermore, in the winter of 2003, supported by Professor Kesheng Wang, I was admitted to the PhD program at the department of Productivity and Quality, NTNU. This way I engaged myself in a study encompassing both NHH and NTNU curricula.

In completing my PhD thesis, I first of all will thank Professor Kesheng Wang for being my principal supervisor, supporting my work and making certain that I kept to my schedule. Kesheng being a keen student of knowledge, both what is stored in the human as well as organizational memory, has given me valuable insight into his work. His international work on Computational Intelligence has opened my eyes to a tantalising scientific discipline.

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Ove Rustung Hjelmervik

overh@online.no

Abstract

The ability to develop operating routines through the support of information and communication technology (ICT) is being valued by the business community as a source of competitive advantage in the information economy; and research concerning the facilitating role of such technology in relation to organizational learning and development of routines is therefore required. In this thesis the focus is directed at the relationship between communication technology and the development of routines in an industrial organization leading to enhanced value creation. The impact computer-supported knowledge representation has on an organization's ability to change through development of operating routines are addressed, and propositions concerning the effects on different aspects of communication technology (e.g. system structure and functionality) and organizational environment (e.g. organizational learning, empowerment, systemic innovation, and absorptive capacity) are developed. The moderating role (i.e. the learning mechanisms) of an organization's ability to learn from, and share, experience within a multilevel nested organizational structure is also discussed and evaluated.

The main goal of this study has been to reveal and explain how operating routines are developed and learned through ICT-supported knowledge representation, and on this basis build concepts and methods that can be used to improve the development of operating routines in business organizations. In this context we have developed a deliberate organizational learning model (DOLM). The main contributions of this work are the following:

- Development of operating routines may be enhanced through computer-communication given a multilevel nested iterative organization structure applying an ICT-supported deliberate organizational learning model.
- Empowered employees are willing to participate in the development of routines through such communication by sharing experience that may impact on operative and strategic activities, resulting in enhance productivity.
- Employees participating directly, or indirectly, in the design of ICT systems are positive to applying computers for the purpose of organizational learning and development of routines.

- Because of their capacity to absorb new knowledge within a context specific domain, experienced operational personnel understand new routines presented through ICT-supported deliberate organizational learning structure.

Many people take it for granted that computers support organizational learning, yet to the best of our knowledge little empirical proof has been forthcoming through the literature. We will argue that the development of operating routines can be enhanced through the application of a *computer-based deliberate organizational learning model*. Furthermore, our case identifies a *multilevel nested iterative* organization structure as a contributing mechanism for such a model to succeed. The current theory on empowerment does not say anything about employees' willingness to apply ICT, nor does it suggest that employees are willing to share experience through the application of ICT. Our findings clearly indicate that empowered employees are applying ICT in the pursuit of developing routines and are willing to share experience through computers. Furthermore, our findings suggest systemic innovation theory to include employees that are indirectly participating in the design of systems as being positive to using computers. Such indirect participation includes employees knowing of colleagues participating in system design. While some theories argue that employees learn new routines through story-telling within a community-of-practice (COP), our data indicate that new operating routines transferred to experienced operators through ICT can be learned. Experienced operators learn new routines through having an absorptive capacity because knowledge will diffuse more rapidly among employees who have prior experience.

Our case study shows that organizations can develop operating routines supported by knowledge represented in ICT. *This research contributes to the understanding that development of routines can take place through an ICT-supported deliberate organizational learning model applied within an employee-empowered multilevel nested iterative organization structure.*

A best practice knowledge management (KM) system representing the firm's operating routines is studied over time as it is being implemented in the business units within a corporation. Our focus is on change processes through development of operating routines by studying how the organization can learn from its experience, share such experience and from accumulated experience develop new routines. This thesis is a longitudinal explorative case study, basing its findings on in-dept interviews at operator, middle and senior management

levels. We are basing our observations primarily on the cognitive/behavioural organisational learning theory. Based on our observations we mapped and analyzed if, how and under which circumstances an organization, supported by ICT-represented knowledge, is able to develop operating routines and thus enhance the value creation in the company. On this basis we have developed a set of "within-case" propositions. These propositions predict how and under which circumstances organizations may learn through the support of ICT, leading to development of operating processes and routines for the purpose of enhancing value creation in business organizations.

Some literature argues that knowledge is tacit and organizations learn only through practice. Our findings cannot confirm this. We have through the application of the cognitive/behavioural theory tested out organizational learning. Our research indicates that in context specific situations experienced employees can learn new routines through computer systems support. However, in order for organizations to learn, it is not enough to just implement a computer system. Our findings suggest a need for the implementation of a strategic process where the development of an integrated DOLM is the objective. Furthermore, certain organizational structures need to be in place for such a system to be applied resulting in capturing and sharing accumulated experience. In this sense strategy, change processes, and KM systems are intrinsically linked.

This research is based on a case study of Hydro Aluminium's BestPracticeSystem (BPS), a successful in-house developed enterprise KM system implemented in the period 2003/4. The case study demonstrates the usefulness of the model to support change processes through development of operating routines, and the improvement in productivity that can be achieved by implementing a deliberate organizational learning model in conjunction with a process oriented manufacturing practice. Knowledge represented through ICT can drive value creation.

Table of contents

The error of youth is to believe that intelligence
is the substitute of experience,
while the error of age is that experience
is the substitute of intelligence.
Lyman Bryson.

1 Problem setting

We will in this chapter introduce the problem area and describe the research setting. From this presentation we will identify observations made in the field which lead us to research computer-supported organizational learning. Furthermore, we will identify the positioning of our work and describe the phenomenon as it relates to an industrial setting, and on that basis state the research question.

1.1 Introduction

This research investigates emergent features in development of operating routines. Our focus is the use of ICT-supported knowledge representation and probes if such representation can support a firm's development of operating routines for the purpose of enhancing productivity and value creation. This is of primary importance for a firm in the way it uses resources in its execution of business. As the world is changing it is important for firms to participate in its development. It is a common belief that ICT can be a source of competitive advantage through strengthening an enterprise's knowledge, and based on our research we would like to explore this issue. An organization's ability to renew operating routines based on accumulated experience depends on its ability to learn. Organizational learning, thus, is antecedent to routine development. Much research addresses this subject from a multiple viewpoints. However, in this stream of literature we have to the best of our abilities found little evidence on the application of computers as a support in developing operating routines. What is new in our contribution is how organizations are able to use computers in relation to development of routines. Research related to development of routines through the support of computers has, to our knowledge, primarily been done conceptually, and may therefore be poorly understood (Zollo & Winter, 2002, Brynjolfsson & Hitt, 1998). We hope to add some theory to the literature while offering some insight into operational management.

In today's society we read in the popular press about competition from low-cost countries, such as China, forcing companies in high-cost countries, such as Norway, to focus on human capital – that is knowledge. Companies competing under condition of change, such as changing processes, technology and regulations, need to be able to develop an ability to adjust (Prahalad & Hamel, 1990). For the purpose of organizational learning routines are developed and transferred within the boundary of the firm. In order for the organization to effectively develop and transfer routines and processes supported by computer systems it is important to understand such systems' effect on value creation. If development of routines, aided by computer-supported processes, could not be achieved the development of organizations would be slow and uncertain (Kogut & Zander, 1992).

This thesis is organized as follows: The rest of this chapter will describe the research setting, positioning the research and describe the phenomenon. In chapter *two* we clarify the central concept, review the literature and identify the area where the literature lacks a theoretical understanding of the phenomenon under study. In chapter *three* we will develop a theoretical perspective and offer a tentative research model. In chapter *four* we describe the case study method, including research design, data collection, analysis and validation. Chapter *five* contains analysis of data and on this basis we report our findings. The findings are discussed in chapter *six*, with a summary, implications and future studies in chapter *seven*.

1.2 Research setting

This study focuses on development of operating routines. Routines are stored in Hydro Aluminium's (HAL) internally developed Best Practice System (BPS) implemented in 2003/4 for the purpose of improving productivity. BPS is a company wide, firm-developed, ICT system aimed at supporting a process-oriented organizational structure focusing on developing, sharing and applying operating routines, and supply relevant documentation linked to work-practicing routines. BPS is in HAL termed a knowledge management system (KMS) while operating routines are called best practice (Davies & Kochhar, 2000, Voss et al, 1997; Voss et al, 1995). We will in this study apply best practice as operating routines (Eisenhardt & Martin, 2000). BPS represents a planned process, making available to the employees a technology capable of supporting organizational learning and routine development within the rank and file. Focusing on organic growth, it was important for the company to involve employees in improvement and innovation in order to achieve its planned strategic position within the industry.

We will evaluate the applicability of the new ICT system, BPS, against the old system, SDOCS, which was replaced during our investigation. The installation of BPS was a management decision for the purpose of improving routine development. SDOCS only stored current routines, with little capacity in form of linkage and experience feedback functionalities. During this longitudinal study, stretching from 2003 to 2006, it struck us that some of the observations made warranted further inquiry. For example management's strategic focus on empowerment, a organizational process structure, and its use of ICT-based knowledge management systems to support employees' participation in development of routines, led us to investigate the issue of computer supported knowledge representation in development of routines. In the following we will briefly present HAL and its strategy, the sectors studied, and the issue: ICT-supported routine development.

1.2.1 Company description

Hydro Aluminium AS (HAL) is a subsidiary of Norsk Hydro ASA (Hydro), a global oil, energy, petrochemical and aluminum producer. Hydro was founded in 1905 with the production of fertilizers. Already during World War I Hydro experimented with aluminum production. Aluminium is produced through the conversion of bauxite to aluminum oxide (alumina), which again is converted to aluminum through a smelting process reaching about 1000 degrees Celsius. Through an electrolyses process taking place inside a furnace (vat) the oxygen is removed and the result is pure aluminum. During the smelting process energy goes through a positive anode to a negative cathode. While the cathode is part of the vat, the anode is being part of the process, and is replaced routinely. Replacing the anode is a major operational activity, where you have to close down the furnace before replacement of the anode (Prebake method). The older method, Søderberg, is a continuous process whereby the operator adds small bites of carbon on top of the anode. Today Søderberg technology is regarded as a polluter and therefore being replaced with the Prebake method, which is more benign both within the factory and for the outer environment.

With its about 27.000 employees worldwide, Hydro Aluminium (HAL) is among the largest integrated aluminum producers in the world. In 2000 HAL changed organizational structure from a sight-integrated aluminum producer to process-integrated sectors, with a CEO (President), and a senior director (Sector President) for each of the sector units. While sight-integration meant that each local unit was responsibility for a production-to-market operation,

the process integration means a global responsibility for each sector (fig. 1.1). An upstream sector (i.e. Primary Metal) is always regarded as a source, and a downstream sector (i.e. Metal Products) as a customer. Previously, the sight manager reported to CEO. Today the Sector Presidents reports to CEO as well as being an executive vice president in HAL's Executive Group. Transactions cost between the five separate operational activities are based on world market for aluminum production. HAL is represented with one, or several, sector operations within each of their operating locations. Thus, at each operating sight, one may find production units belonging to both Primary Metal and Metal Products. Each production unit within a sector is thus linked together on a global basis. From each sector's value change is a cascading of best practices, sub-practices, work processes and work activities that makes up the total value change of the sector.

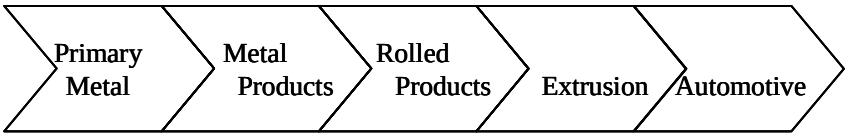


Figure 1.1. Hydro Aluminium value chain

Company Strategy

HAL is marked leader within products such as aluminum foils, building systems, and car parts such as motor blocks and chassis. Through HAL's focus on aluminum in cars, it has achieved a status as a six-sigma quality supplier of aluminum to prestigious car manufacturer. In order to maintain such high rating the company's strategy has been to put more emphasis on the human resources throughout its organization, and let them participate in the development of operational processes through experience sharing and best-practice development. With fully integrated production facilities around the world, its focus is on *being the most innovative aluminum company in the industry* (Annual report, 2001). Furthermore, Hydro Aluminium's overall ambition, to be reached by 2007, is *(1) a "top-tier" global company, (2) Exceed customer expectation, (3) Create sustainable business solutions, and (4) the most profitable in the industry (document).* While HAL has grown organically as well as through acquisition, it is now focusing on employee competencies. In so doing, there is a cost element that has to be considered. Included in the purpose of the best practice development is a requirement to transfer both a more effective production method as well as more efficient operating routines to all units in its drive to remain industrial competitive. To achieve its long-term goals, working environment will be a key focus. "*Best practice routines to master and improve the*

operating environment and HES (Health, Environment and Safety) will be introduced and measured against KPI goals. Examples on HES are ergonomics, chemical handling, heat stress, noise, vibrations, environmental pollutions, safety, security and other working environment" (document).

Within the aluminum industry there is a delicate balance of supply and demand, which currently is in equilibrium. New green-field capacity, if added, will reduce profitability throughout the industry, and result in retaliation from competitors, according to a Sector President. It is more profitable to close expensive capacity than to build new. Thus, closure of unprofitable production lines, such as Søderberg production technology, and improvement of efficiency and effectiveness in general, are steps to improve profitability. More efficient measures have been introduced. The most important is Total Productivity Management, a quality circle concept within Quality Management. The circles are established on the factory floor to improve daily activities - from shift schedules to cleaning the washroom. The employees are organized in groups focusing on different aspects of the operation. Suggestions are either sent via the foreman or dropped into the suggestion box. In order for HAL to achieve its goal, therefore, management has recognized the need for organic growth, based on current capacity. The strategy is to focus on organic growth through employee **empowerment**. This can be achieved, according to HAL's strategy, by developing and implementing a **best-practice knowledge management system**. A tool for achieving organic growth, without adding new capacity, is BestPracticeSystem (BPS), developed by the firm for the mutual benefit of all the employees. A basic assumption for the success of BPS, therefore, is the employees' ability to apply the business system efficiently and effectively. Furthermore, management has stipulated that their strategic success not only hinges on employees' ability to apply the current practice represented through BPS, but by empowering employees they also expect **improvements** to current practice through **organizational learning** and **routine development**, and thus **enhanced productivity**. To achieve this vision HAL has adopted a process oriented work practice where the value creating processes will continuously be challenged by the employees through improvements and innovation. In other words, employees' competencies are valuable once it is transformed into action. Summarized, HAL's strategy has been put into action through the following steps (Document):

- *Establish an **improvement** organization and **culture***
    - *Ensure process ownership and roles*
    - *Build the network*

- *Establish Best Practices*
- *Establish a common set of policies and business principles*
- *Develop and implement tools and mechanisms for continuous improvement (e.g. BPS)*
- *Challenge continuously existing Best Practices*

1.2.2 Sectors studied

In Norway HAL is represented with four wholly owned production units, located in Karmøy, Høyanger, Årdal and Sunndalsøra. Its global head office is in Oslo. The three first factories produce aluminum by applying both Søderberg and Prebake technologies. In Sunndalsøra, the largest production unit in Norway, only Prebake is used. Hydro's Board of Directors has decided to face out all the Søderberg production units in the period 2006 to 2010. However, it is uncertain if they will be replaced by Prebake production lines. Høyanger and Årdal has least possibilities for such replacement, partly due to the space available at their locations, placed as they are between 1000 meter high mountains deep in two narrow fjords off the Sognefjord, the worlds longest fjord. These two factories will be running as long as they are profitable, that is, they will be closed down if unprofitable. Karmøy has more space, and its current Prebake has twice the capacity of the other two. So, even when Søderberg is closed down at the Karmøy plant, its capacity will still range high in European terms. An offer by a Canadian firm to buy Høyanger and Årdal was turned down by the Board winter of 2005. A new offer proposed during fall of 2005 was also turned down. We will in this study focus on the two production sights Karmøy and Høyanger, and the sectors Primary Metal (PM) and Metal Products (MP).

1.2.3 Replacement of a document handling data system in HAL

Background

There was a radical change within the aluminum industry during the period around the millennium shift. The competition was well under way with changes to management and production structures. New methods for obtaining continuous improvement and innovation in operation were applied by some of the most important competitors, such as ALCOA, the world's largest integrated aluminum producer. For HAL it meant restructuring the organization and developing a business system capable of representing a common best practice for each technology, regardless of the location. In 1999 some managers at Karmøy started looking for an alternative to the SDOCS - a computer based system for company

procedures, organized according to the production location. Prior to restructuring, each location had their own set of operating procedures. In 2001 it was decided to build a computer-supported best practice system (BPS) covering the four Norwegian production units plus Oslo (4+1). The purpose was to have employees participating in developing and using operating routines stored in the BPS.

"We will agree on the company's best practice, and continue to develop this wherever it is relevant". Sector President, Primary Metal, HAL.

AluMagasinet, June, 2001, p. 11.

"HAL Business System will be our most important tool for planning, developing, operating, result measurement and follow-up". Director, MP, HAL.

AluMagasinet, June, 2001, p. 12.

"HAL Business System shall be able to present our "Best Practice" in a simple and understandable manner". Project Manager, BPS.

AluMagasinet, June, 2001, p. 12.

The old system

SDOCS: Steering DOCument handling System

Before the reorganization each plant location had its own quality system, documented in Word. The system, SDOCS, was Lotus Notes based. It could not be made organization wide because each sight had produced its own standard. In addition to a factory-specific routine, the organization was hierarchical based with each plant manager the most senior next to the CEO. That implied a breakdown of work activities from the Plant Manager, dividing responsibilities up in sight-specific tasks. Furthermore, since HAL's operations were departmental rather than today's work-process orientation, no official communication was organized between the departments. Thus, an Information and Communication Technology (ICT) to present routines in a process-oriented, work-flow illustrating, manner, by utilizing technology such as Domino.Doc and Visio, could not be applied as SDOCS was basically a document handling system. The development team had applied Lotus Note technology, but only to point to front page of a document in a hierarchy. Thus, if the document was 30 pages, you had to read through all of it before you could decide what part you were interested in. As a result of strategic and operative changes, SDOCS was replaced by BestPracticeSystem - BPS.

1.2.4 Best Practice System

Purpose

The philosophy of BPS was stated as follows (Document):

- *Make our workday simpler and with a better overview.*
- *Make the work processes safer, more efficient and with an improved quality*
- *Operating identical processes using same best practice across HAL*
- *Developing new knowledge through sharing experience*

HAL's business system is designed to guide the teams to a safe execution and operation of routines. According to internal documents, BPS is

> "*a holistic system developed and built on the idea that cooperation and the application of common insight and competencies, is an important competitive advantage"*.

Furthermore, according to the project manager transfer of knowledge was important for understanding, but equally important for development of new routines.

> *"To ensure that we are able to transfer knowledge we had some starting guidelines for the project, and have built a few new based on project experiences. Simplification has been the ground rule, to make things as easily understood as possible. The world and production processes are so complicated anyway, so we wanted to help people by making things easier to understand, not following the path of complexity! Thus a simple methodology is needed to represent our experience and knowledge. We found this by having as few information steps (3) as possible, by combining flow charts with few symbols and activity lists, and by organizing information according to processes, not organization or themes or other interesting ways of putting up our encyclopedia."* (Document).

The purpose of BPS is to take advantage of common insight and capability by sharing own experience with colleagues across HAL, and to apply same practice wherever the technology and processes allows it. By such action management will reduce deviating practices and costs of operation, resulting in better financial results. Furthermore, it has been important for the project to make information easily available, and in a more complete form, for the employees. This is a radical shift from previous system - SDOCS. BPS user-friendliness is part of employees' anticipated acceptability. Through teamwork, both within and cross business units, BPS is expected to encourage development and application of a common practice and

solutions. Also for infrequent work processes, the business system is expected to guide the teams to a safe execution of an operation. With Best Practice the company means operating routines required for the production of aluminum, while operation is referred to the company's total business process (see fig. 1.1).

Establishing both performance goals and developing new best practices is a challenge to management. Routine development, through the application of a common ICT-supported knowledge representation, is only one of several forces influencing the result of the organization. Yet, management expects BPS to support the development of operating practice on a continuing basis. BPS' organizational learning process is a multi-step process starting with current best practice and ending with implementing new best practice. The firm's quality policy document states that *processes and deliveries shall satisfy the requirements, needs and expectations of customers, employees, owners and society. This shall be achieved by focusing on:*

- *Quality which requires commitment from everyone*
- *Continuous improvement and simplification*
- *Being the customer's preferred supplier*
- *Best Practice in all work processes*

The individual/team will gain access to the results from other units that may be of interest to a team, or of interest for HAL to expose to the units. Furthermore, management opened for employee insight into Key Performance Indicators (KPI). The reason why HAL management opens the KPI measurement result to its employees is, according to the project manager, "*to let the units see the connection between what the teams do and the results the teams are participating in creating" (Project Manager, BPS)*. Management wishes to demonstrate the improvements in the results due to the use of employees' application of their competencies together with best practice. This way, employees are participating in producing better results faster.

Organization

BPS consists of FIVE elements: (1) the ICT software system, (2) representation of value-creating work processes, (3) representation of best practice routines to carry out such work processes, (4) experience transfer function allowing experience to be transferred to the

relevant process owner, and (5) a support function where advice can be sought for questions asked. Within a work process, each work activity consists of three elements: (a) who is the supplier of work, (b) who is the customer of the deliveries, (c) and what does the delivery consist of - a description of all relevant details of what to deliver, how to execute the activity, and all relevant procedural and supporting documents such as pictures, video, etc.. Charging a production furnace is a work process within the business process (ill. 3 below). The work process consists of an operating routine executing several work activities. An actor responsible for charging a furnace will act according to that routine. However, the routine is cascaded down from a larger routine, that of operating the Business Unit within the Sector.

For the purpose of this research, we are going to monitor whether or not employees are able to learn operating routines, such as “charging a furnace”, through ICT. If s/he/team is able to gain experience from practicing the routine, and then able to sharing such experience with the rest of the organization, for the purpose of applying the experience in form of a new operating routine, then organizational learning and development of routines have taken place. Furthermore, we will inquire into the process of development of new or improved routines.

Prior to changing from SDOCS to BPS, the company restructured its organization to allocate responsibilities for each process. Each major work process has a *process owner (PO)*. The process owner, such as PM’s Sector President, is a line or functional manager with personnel and budgetary responsibilities. However, due to the need for a continuous “hands on” requirement, the task of maintaining an updated process is delegated to a *process leader (PL)*. S/he is thus representing the senior manager responsible for the function and reports to the process owner. PL manages the process on a daily basis, including sending out new routines. PL plus senior members from operating units take decisions on routine changes which do not impact on policies and major strategies. PL takes unilateral decisions on minor changes impacting more than one geographic unit, while local operating units (also called business unit) take decisions related to local practice of no strategic importance. The consequence of HAL’s decision to transfer power to teams and employees out in the organization was a flatter structure, making the decision-processes shorter. At each production unit, such as Høyanger PM, the process owner is represented with a *Superuser* whose responsibility is to support operating employees regarding the codification of experience, and secure implementation of new routines to be applied by the unit. *Integrated teams* were given authority to take action if,

or when, it was required due to extraordinary situations. A team's senior employee is always responsible for its 'delivery' of the assigned tasks, but without personnel responsibility.

By restructuring its operation from functional activities to process activities, HAL achieved a more informative structure of the firm's value flow. According to documents issued by management, a process oriented operation offers certain advantages over an organization managed through functional responsibilities. These advantages include (document)

- *Communication of complex procedures is simplified.*
- *Customer focus is improved and ensured by process orientation*
- *Processes are organization independent*
- *Process thinking is being promoted by quality rating companies and standards*
    - *Organizations perform more effectively when all inter-related activities are understood and systematically managed*
    - *Organizational performance is maximized when it is based on the management and sharing of knowledge within a culture of continuous learning, innovation and improvement.*

There is a direct link between the process oriented strategic thinking and its execution using BPS, and the management of process tasks and key performance indicators (KPI). That is, through strategic goals KPIs are formulated and established and reflected in the routines that guide work activities. As employees have been empowered to improve/change routines and work processes, the KPI - routine mechanism allow employees to influence strategic goals. This further enhances the quality of the products delivered to customers. Two factories, applying same technology, should be able to deliver similar quality through the application of identical best practice.

System structure

HAL' requirements to system and its values can be summarized as follows (document):

1. *One system, which will make the firm a "world class" aluminum supplier.*
2. *Through the use of a common ICT-storage system secure that same work processes, using similar technology, are subject to identical best practice across the organization.*

3. *Support a standardized and simplified value-creating process based on best practice work processes for management, operation and staff.*
4. *Continuous improvement and development of work processes by reflecting on efficient and effective experience, transferred across the organization as standardized best practice through advanced use of ICT*
5. *Training of new, as well as experienced, employees through the use of BPS*
6. *Secure that best practice reflects the organization's KPI goals, of which both are made available through a common ICT platform.*

The software system on which BPS was developed, a knowledge management system, is called Corporum. The Norwegian firm CognIt AS delivered the system. The technology behind Corporum is standard products based on common technology. The system allows for a continuous update of best practice through the participation of individuals, teams and process owners in a nested iterative institutionalized structure[1]. It secures an overview of all processes within each business unit, as well as linkages to all relevant documentation within each work activity. The system envisages changes to a routine. Entering into the BPS, the first functional web page to meet you is the corporate page where one can see the value creating processes within HAL.

[1] According to Scott (2001), also institutional change happens through an "interaction to produce structures which, over time, are reproduced but are always subject to change" (Scott, 2001:186).

Illustration 1. HAL's knowledge management system Best Practice System: entrance picture

A web page illustrating the business process for the Primary Metal and Metal Product business units, together with common management and support processes, is reproduced below. You can choose the language of English, Norwegian, German, French or Spanish by clicking on the relevant flag. Illustration 2 illustrates how BPS looks like when opening up the PM/MP area.

HAL Best Practice knowledge management system

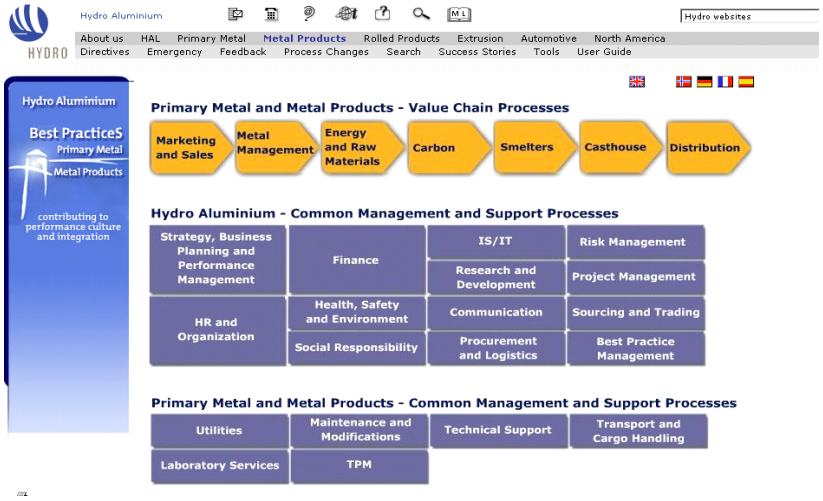


Illustration 2. HALs BPS: Primary Metal and Metal Products entrance picture.

In the system one finds documents describing the core processes in detail, such as production of aluminum, and functional processes, such as sale of aluminum. Each main process has a drill-down function, ending up in a work flow diagram and individual work activity sheet with links to each document of relevance to the work activity. Illustration 3 represents the document hierarchy found in BPS and illustrates how one can navigate down into each activity and its description.

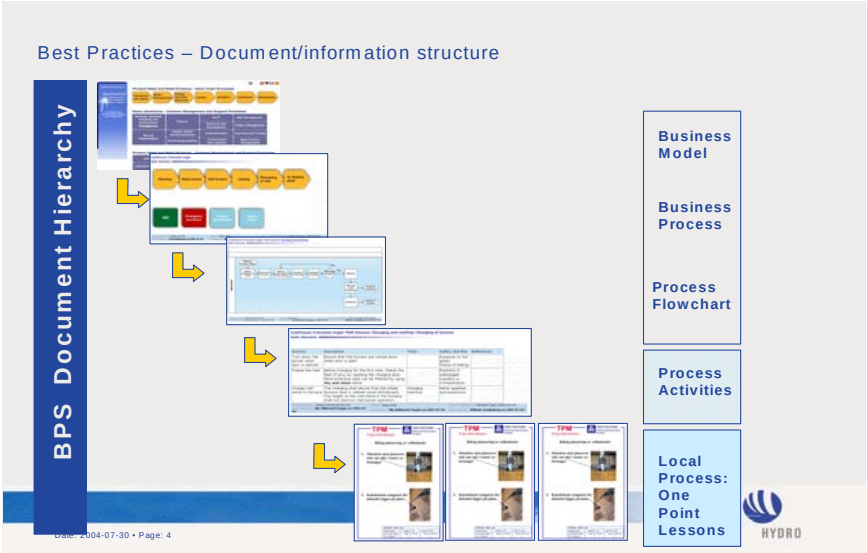
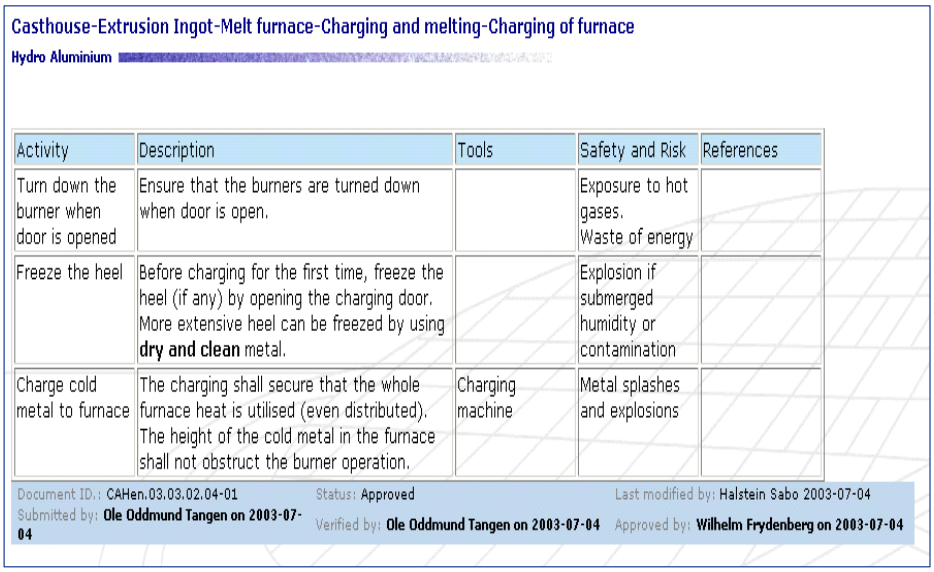


Illustration 3. HAL's BPS: Best practice document hierarchy

One final function regarding BPS not available in the old system is collection and systematization of experience made by the employees. An experience made by an employee can be written within the context of a process activity and forwarded to the process owner. Upon receiving this experience the process owner know now exactly in which work activity this experience was made. Should one choose to change the practice the process owner has two choices: (1) leave it as a local experience if they find it relevant or (2) it becomes a part of the official best practice and shall be used by all employees working on identical technology. By this experience transfer technique, the system has supported the firm's routine development process by supporting a continuous improvement process. Illustration 4 illustrates a best practice which has the status: approved.

Linked to the best practice is an illustration of a One-point lecture - TPM (illustration 5). This particular illustration demonstrate how the cover of a cell is suppose to look like when it is



Casthouse-Extrusion Ingot-Melt furnace-Charging and melting-Charging of furnace

Hydro Aluminium

Activity	Description	Tools	Safety and Risk	References
Turn down the burner when door is opened	Ensure that the burners are turned down when door is open.		Exposure to hot gases. Waste of energy	
Freeze the heel	Before charging for the first time, freeze the heel (if any) by opening the charging door. More extensive heel can be freezed by using **dry and clean** metal.		Explosion if submerged humidity or contamination	
Charge cold metal to furnace	The charging shall secure that the whole furnace heat is utilised (even distributed). The height of the cold metal in the furnace shall not obstruct the burner operation.	Charging machine	Metal splashes and explosions	

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Illustration 4: HAL's BPS: Work activity document in a best practice routine.

properly placed on top of the cell. In addition to such illustrations, one can attach multimedia such as pictures, sound, illustrations and video clippings.

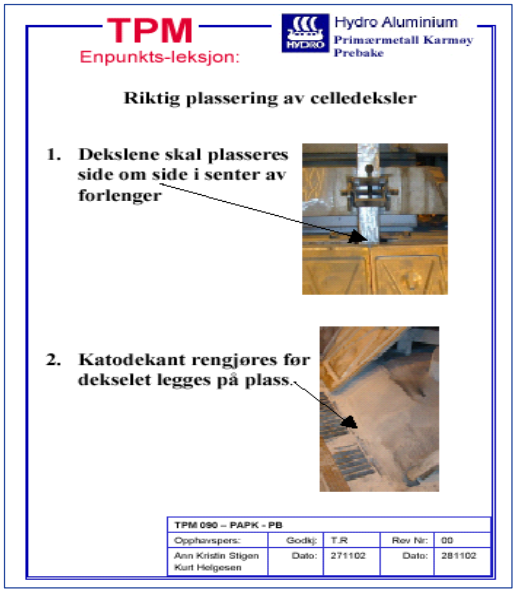


Illustration 5: HAL's BPS: One-point lecture in best practice routine.

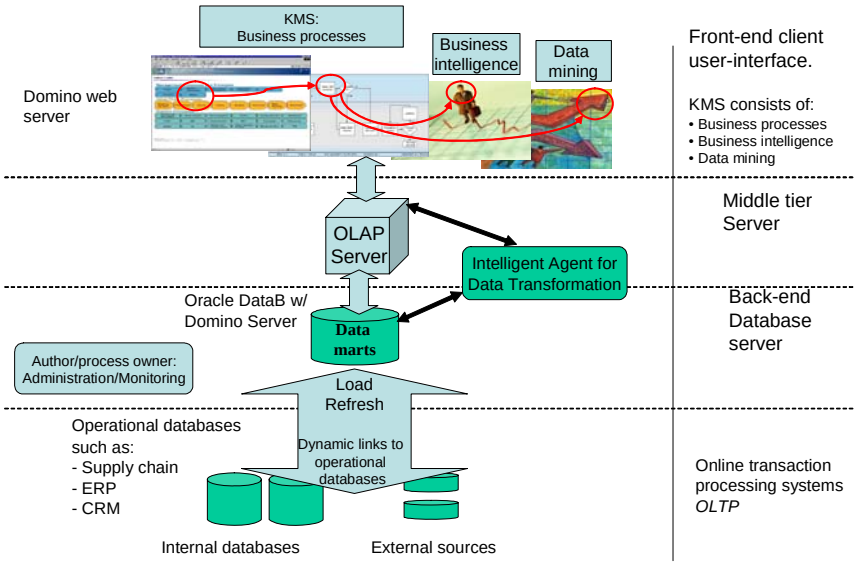
Having developed the BPS' IT-shell, the project team seconded employees from each of the sectors to develop work processes and best practice routines together with related documents to be stored in BPS. Although not included in HAL's current versions of BPS, a KMS can include more sophisticated data technologies such as business intelligence and data-mining (see Frame 1 below). These technologies can offer solutions which are able to utilize

knowledge repositories hidden in complex and difficult enterprise information infrastructure. Based on the BPS system, a KMS concept encompassing BI and DM has been described below in frame 1: A holistic knowledge management system.

The case for a holistic Knowledge Management System (KMS)

Knowledge Management System is, according to some, useful to aid the managers and workers to make fast and right decision for competitive advantages. There are three important knowledge components within the modern manufacturing firm: **Knowledge Management** (KM), **Business Intelligence** (BI), and **Data Mining** (DM), each of them operates on an ICT platform. Knowledge Management applies business processes for the purpose of levering knowledge by making routines easily accessible to all employees. The business process structure also secures sharing of operative experience leading to management-employees cooperation for developing routines and processes. Business Intelligence is a top-down system whose function it is to coordinate different technologies, software platforms, specific applications, and processes for the purpose of converting data into information, and support better decision-making faster for the users through a rational approach. Making better decisions faster includes being able to react faster to market requirements, and close the time gap between goal implementation and market requirements.

Data can also be investigated using more advanced analysis technology such as data mining to find patterns that explain behavior or uncover trends that are hard to see with the naked eye (or, searching for a gem). Data mining is a bottom-up approach that is becoming increasingly popular. Instead of using summary data as a starting point for analyzing trends, DM can be used to analyze relationships in detailed data, making the arena for analysis vastly greater. Data mining is an integration of systems, such as computational intelligence (Artificial Neural Network, Fuzzy Logics and Genetic Algorithm), machine learning techniques, data base technology, statistics, data visualization, and spatial data analysis. By performing data mining, interesting knowledge, regularities, or high-level information can be extracted from databases and viewed or browsed from different angles. The discovered knowledge can be applied to decision making, process control, information management, and query processing.



Frame figure 1.1: Structure of a Knowledge Management System

Frame figure 1.1 depicts a combined KMS, BI and DM system where all information and analysis is channelled through the firm's business process containing the total value chain. From this position employees and management can reach all relevant information related to a given process, be it analyzing a market situation, finding new production pattern or executing a production order.

Frame 1: A holistic knowledge management system

Organization structure of BPS development and implementation team:

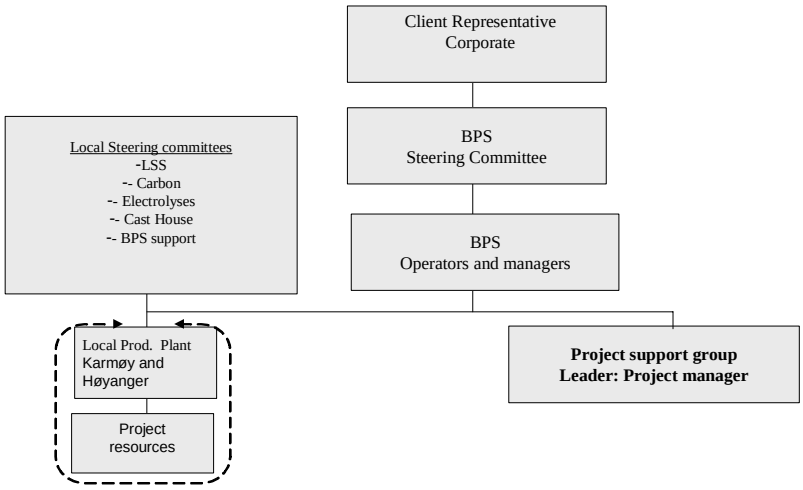


Figure 1.2: HAL: Project organization BPS

1.2.5 Implementation process

Each production and functional unit operating within the HAL system has access to all of the firm's work processes, in either a local language or in English. All data is entered only once, by the process leader/Superuser, and shared through the accessibility by each employee within the organization. Furthermore, should an employee be in doubt as to the current practice related to his/her task, s/he can enter the process relevant to his operation. There is only one copy, the original. The effects of standardization of common work processes are believed to be considerable once experience with the system is gained.

Implementing a new system and closing an old may create problems with the organization. According to the project manager, such implementation required the following action (document):

- *We needed:*
    - *Strong Management commitment*
    - *A strong development method*
    - *Good Facilitators*
    - *A good and stimulating system*
    - *A project team with real believers*
    - *…and ambassadors from each plant*

- *Anchored in the company's strategy*

The implementation process consisted of several steps. Each Sector established a Steering committee, and for each location, a separate implementation team under the auspices of the project team was established. HAL planned a sequential implementation plan to be rolled out into each plant based on the implementation plan for each Sector. This way the project team had the opportunity to correct any mistakes that was done at the beginning of the process.

Initially, BPS should only be implemented in the four factories in Norway, plus Head Office. As success was demonstrated, the team was asked by the CEO to implement it in Hydro Aluminium worldwide. According to the implementation plan, the implementation should be completed within three years after the start of the development in early 2001, that is, end of 2003. According to the project manager this target was met. In his comment to a group of senior executives in April 2004, President of HAL urged his colleagues to share the enormous amount of competency in the firm. *"We will have to make sure that this does not remain a talent of individuals, but that we share it within our organization and make it a Hydro Aluminium competence"* CEO, HAL (document).

Through active support offered by the executive team the project team succeeded in securing accept for the system in the different Sectors. For each location an implementation group was appointed lead by the Superuser, who had also participated in the best practice development work. The system development group participates in presenting the system in form of a half-day training course. In order for the system to be dynamic and relevant, responsibility for maintenance of system and business processes was separated. A core group representing HAL was appointed for operating and maintaining the system, while the best-practice maintenance and development for a sector is the responsibility of each process owner.

For MP-MS, the implementation went according to plans. However, for PM it was different. Karmøy PM was first out. Two of the informants, an operator and a staff both discovered the mistake made by the development team, of which the operator had been a part. The development team had based the PM's search criteria on the generic structure of aluminum production rather than using technology as commonality. This functioned well in MP and other sectors, but not in PM. The result of such structure was that it took considerable number of clicks for an operator to zoom in on his work process. The PM employees responsible for

the implementation, representing all four Norwegian production units, decided to stop implementation while restructuring of PM's BPS was taking place. It was important for the employees to obtain approval of management for this action. Our informant managers at both Karmøy and Høyanger recognized the problem and supported employees request for postponing the implementation until the new version was released. The new structure of PM's BPS was based on technology, with the argument that you first choose technology then location. It took the group 12-15 months to complete the new navigational structure. Implementation in Karmøy took place ultimo 2004, and January, 2005 for Høyanger.

1.2.6 Case: Hydro Aluminium

Being a theory building, explorative, case study, we need to resolve the research question through seeing "different instances of it, at different moments, in different places, with different people. The prime concern is with the condition under which the construct or theory operates, not with the generalization of the findings or the settings" (Miles & Huberman, 1994, p. 29). We are studying a bounded setting, an organization. Thus our selected case is the organization. Within this case we will analyze groups of actors for comparison. Our two settings, Karmøy and Høyanger, represent different sights, different business units, and different team responsibilities.

Our level of analysis is Hydro Aluminium, with embedded units to be studied. The two factories to be described are *Karmøy* and *Høyanger*, which again contain *Primary Metal*, *Metal Products*, *Operating* groups, and *Staff* groups. Our data will be the same, a set of interviews at management and operational levels, observations and documents. Each group is nested in the same organization, and part of the same nested hierarchy.

1. *Location: Karmøy and Høyanger*

Both Karmøy and Høyanger are fully location-integrated aluminum producers, producing both molten aluminum and aluminum bars and rods. The MP is today a downstream sector of the Primary Metal. As the molten product is delivered from PM, MP is adding ingredients into the molten aluminum to meet certain customer requirements for the delivered alloy. Thus, PM has become MP's supplier and MP is PM's customer. While PM Karmøy can produce twice that of Høyanger, Høyanger has received company award for most efficient producer over the last few years. The center for Marketing and Sales (MS) within Metal Products (MP-MS) is located in Karmøy. MP-MS is responsible for marketing and sales in Europe. In

Høyanger about 250 employees are located, while Karmøy is about twice the size. MP-MS has a total group in Europe of about 30 employees of which half is located in Karmøy and the rest outside Norway. Høyanger has no MP-MS employees.

Karmøy is located near the city of Haugesund, with a population of 30.000. Karmøy plant is located in an open landscape south of Haugesund and is the sight of several of the company's business units, such as Primary Metal (PM), Metal Products (MP) and Marketing & Sales within MP. Karmøy produces twice the aluminum of Høyanger, on a much larger plot of land. It has both a Søderberg and a Prebake production line. Søderberg will be closed down due to more restrictive pollution standards. This may threatened Karmøy as a production sight. Some of HAL's senior management has been working at the Karmøy location, which, as a geographic region only became an industrial setting in the mid-1960s.

Høyanger is located at the end of a fjord arm of Sognefjorden. It is a small community with no larger neighboring cities. It produces aluminum from two production lines: Søderberg and Prebake. Søderberg will be closed down within 2007 due to more restrictive pollution standards. There is no available land for expansion. The management group is small, but dedicated. The senior manager at the sight has a close contact with his employees, something which is highly regarded by the employees. Høyanger has been topping HAL's efficiency KPI for some years now. Thus it is one of the more profitable units in HAL. Høyanger is the location to Primary Metal and Metal Products. However, there is no Marketing and Sales unit within MP. Høyanger is a one-company center. Høyanger has been an industrial setting since 1918. During the last few years the issue of closure has been on Hydro management's agenda. A purchase proposal from a Canadian firm was turned down in August of 2005.

2. Business Sectors: Primary Metal and Metal Products (Marketing and sales)

Primary Metal is HAL's producer of aluminum, all other sectors are downstream. PM is located in four sights in Norway, and produces molten aluminum which is transferred to MP for further processing. The most important KPI elements of the PM business are production continuity and purity of aluminum. One milligram impurity per kilo aluminum may cause drop in profit, as will an unscheduled stop of the furnace. A third element is volume. The higher the volume the lower unit cost. For a factory producing a fraction of that of another unit will put the smaller producer at a disadvantage. Employees at PM are primarily production and maintenance crew, with a few staff and managerial personal. Only the support

staff and management have own offices and computers. There is one computer for operating employees located at the shift foreman's office, and one in the cantina. The operating area is hot and is sometime pollutant, both by noise and air. The new factories, such as Sunndalsøra, are clean and with little noise and air pollution.

MP-MS is located with the central office in Karmøy, and offices in countries such as Germany, UK, Spain and Italy. About half of the staff of around 30 is located in Karmøy. Their major activity is to secure support for the sales and marketing personal, with activities such as customer credit information, accepting new customers, marketing support, etc. The work is important in the sense of securing appropriate information about a customer's ability to pay, and supporting sales force with relevant information such as market intelligence. Some of the employees have own offices and others are sharing offices. All the employees are using computers as their primary work tool. Offices are modern and the climate is comfortable.

3. Work activities: Operating and functional employees

Operating employees are primarily working in areas of stress, such as the production halls. Furthermore, they are constantly facing decisions on how to execute tasks. All activities are based on routines, but is left to the individual/team to execute based on current practice and situation. Whenever an unplanned happening (unwanted incident) occurs employees need to apply experience they possess. Planned activities can be prepared for by going through routines in advance. New processes are learned by going through updated routines.

Functional employees are responsible for work such as personnel, office routines, computer support, safety and environment, marketing and sales. In the production environments they are also assisting operators with such things as writing an improvement proposal, helping operators with the use of a computer, and securing updated procedural manuals. They are working in sheltered areas, often in own office. Their tool is computer. The functional group is small and with large areas of responsibility. The functional groups in PM have different roles than those in MP-MS, but we are considering both groups as functional activities.

4. Employee-participation in routine and KPI development

Management has as its strategic goal to involve employees in improving operating processes and KPI targets. According to our informants it is now a reality to participate in the development of new or improved routines and KPI targets. The processes for achieving such

changes is by having employees/teams, send their experience to Superuser/Process Leader for evaluation of proposals. There are three levels of impacting current practice:

- Local application. This is a sight-specific proposal based on a local experience and practice.
- Sector wide application. Originating either in local proposal or with management. Provided an experience is applicable sector-wide, it becomes a new/improved best practice routine. The development process is part of the strategic focus on empowerment and includes a dialogue between operators and process owner.
- KPI targets. Operating routines consists of a definition of the relevant work activity to be done within a work process, its procedure for securing official rules and regulation, and the best practice for executing the activity. Executing the routine as intended hopefully will lead to KPI target achievement. However, management has left it open to the employees to turn the evidence around by sending in proposals for changing current routines, which again will impact on the KPI target. Thus, employees can affect the current KPI target by having it increased or decreased.

1.2.7 Summary research setting

We have so far in this chapter reviewed the research setting, where we have identified the organization Hydro Aluminium as our case of analysis. Within this case we have two embedded sights where we are observing the actual organizational learning and routine development. It is at the level of the embedded units that we will observe if, how and under which circumstances the local units learn and develop new routines. However, the process of organizational learning is systemized and deliberate, linking each of the embedded business units to a Sector and HAL - the level of analysis. Whenever the local learning process and routine development has relevance at a higher level of the organizational hierarchy, an iterative process of development between employee(s) and process owner will precede the process owner's approval and diffusion to the organization as a new/improved operating routine. Figure 1.3 illustrates the relationship between our main focus and organizational learning and routine development. As can be seen from the figure, a new, institutionalized, routine will have to come from either a local authority, and thus the routine is only locally applied, or from the Process Owner/CEO for Sector/Organizational application. The purpose of this practice is that all routines must first be discussed with management, regardless of how complete a routine is from the employee/group proposing it. This is to secure accept from the

rest of the organization in practicing the new routine, a common structure, and location in the business system BPS.

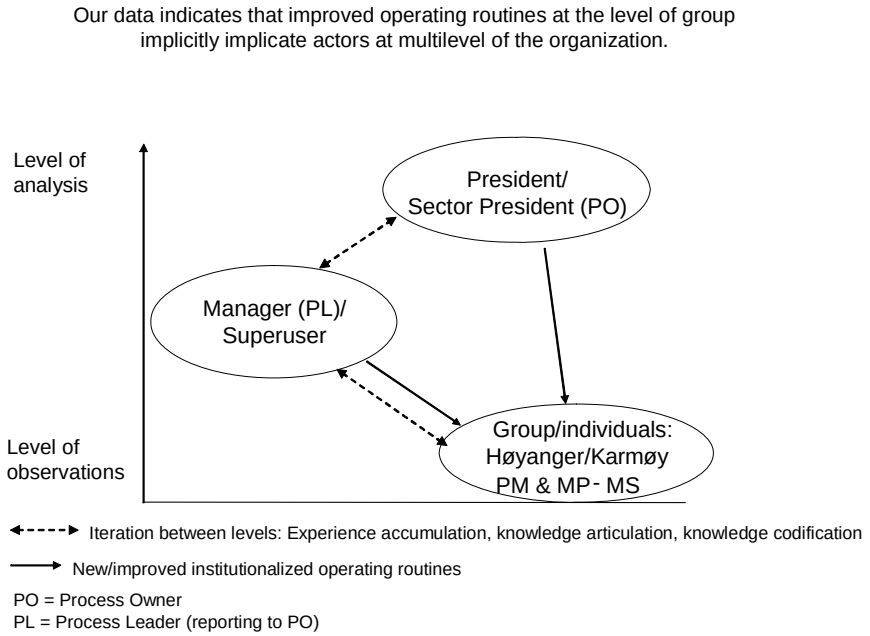


Figure 1.3. Relationship between levels of study and levels of analysis

The focus of the study is based on operating routines, consisting of both operational and functional routines, as found in Hydro Aluminium a.s. In view of industry pressure the company decided to restructure their organization into different Sectors responsible for an up-stream, mid-stream, or down-stream part of the total business processes, and transferring more of decision-making processes to operating units/groups. The empowered employees required access to better and timelier organizational knowledge. The consequence has been replacing a document handling system with a knowledge management system representing HAL's business processes. This strategic decision was linked to management's expectation that employees could participate in improving and developing new operating routines, leading to improvement to current routines, or changes to KPIs and thus correction to strategic focus. Such correction is seen as changes to productivity. We have also seen in this chapter how the BP system was developed.

1.3 Positioning

Our focus in this thesis is computer-supported development of operating routines. However, routine development has to do with the ability to acquire and apply knowledge. Individuals possess knowledge consisting of relations between concepts. Such knowledge structure are

mental templates that individual impose on their environments to give them form and meaning (Walsh, 1995). Some knowledge can be articulated and represented through oral or written forms (Zollo & Winter, 2002; Huber, 1991; Levitt & March, 1988;Argyris & Schön, 1978; Cyert & March, 1963); other knowledge is tacit and cannot be articulated (Nonaka, 1994; Nelson & Winter, 1982; Polany, 1962;), while some argue that learning takes place through personal experience in a communities of practice (Cook & Yanow, 1993; Brown & Duguid, 1991). However, once you have articulated your knowledge, communication with others will be possible. Codified knowledge can be externalized and presented via artifacts, such as computers (Huber, 1991). Represented knowledge can be residing at the individual, group and firm level. Our position is that knowledge is based on cognitive and behavioral learning, where one learns from own and others experience through personal contacts as well as artifacts, such as computers, and then practice such experience.

Our research is based on the view that individuals are social beings who construct their understanding and learn from social interaction, among others in the workplace (Berger & Luckmann, 1966). On this basis organizations learn through rules, procedures and routines (Cyert & March, 1963), and where individuals within organizations apply procedural descriptions of organizational routines to both learn, and explore for, new solutions to more efficient and effective operations on organizations' behalf (Argyris & Schön, 1996).

In what may be described as the foundation work on organizational learning, according to Lyles and Easterby-Smith (2003), Cyert and March (1963) links the role of rules, procedures and routines to organizational learning. Despite recognition of the importance of organizational learning and the development of more efficient/effective operating routines, much of the literature on organizational learning and computers is conceptual. To our knowledge little has been written on the issue relating to computer-supported organizational learning and development of routines under dynamic market conditions. Within production management we know of little empirical knowledge identifying how, and under which circumstances, computers support experience accumulation and routine development.

Renewing a routine can imply either an improvement to, or replacement of, a routine. We will apply *development of routines* to both types of renewals in relation to a firm's operating processes. The study will include an implementation of a computer-supported business system for the purpose of developing, institutionalizing and transferring operating routines within an

organization. The boundary of the study is thus organizational leaning leading to routine development applied within a production organization. We will base our study on the cognitive/behavioral theory as well as organizational learning and knowledge management theories.

1.4 The Phenomenon

> *"If we only knew what we know at TI"* (Junkins, CEO, TI, in O'Dell and Grayson, 1997).
>
> *"If we only had a method for organizing, and access, best practice wherever we needed it, we would have saved 10 million kroner on this transformation fire"* (Senior manager in a Norwegian oil company building a production ship in Korea, 1999).

In this section we will discuss the phenomenon, the relationship between the elements related to the phenomenon, and key premises or assumptions underlying the study. Within an organization, knowledge is not always updated or appropriately organized. This can be seen from the above quotes, as well as from our observations. These references relates to the phenomenon treated in this study: how organizations develop and learn new routines – that is, how experience is being organized and converted to new routines through articulation, codification, and implementation within the firm. Development of Routines *(RD^2)* is about Organizational Learning (OL) and the ability to externalize, store, transfer and apply such knowledge. The process of developing operating routines is the result of an organization's ability to learn and accumulate knowledge. "Very few people understand how organizations create and manage knowledge" (Nonaka et al, 2001a), yet, within business organizations, organizational learning and managing knowledge is being increasingly viewed as critical for firms operating in a global context.

> *"(W)hat firms do better than markets is the sharing and transfer of the knowledge of individuals and groups within an organization"* (Kogut & Zander, 1992: 383).

In this thesis *development of routines* will be related to those processes executed by management and employees in the pursuit of enhanced productivity; that organizational learning consist of cognitive and behavioral activities pursuing routine development; and where routine development leads to new routines. Furthermore, in this thesis we will apply *computers* or *ICT* (Information and Communication Technology) in the sense that the process

[2] While the subject of the thesis is "development of routines" we may, for simplicity reasons, on occasions have used the term "routine development" (RD). In this thesis these two terms are interchangeable.

of OL and RD is supported by the application of computers. When individuals reflect on accumulated experience, and share that experience before it is being codified and diffused into the organization for implementation, we consider this process part of development of routines. We also apply the term *development of routines* to organizational learning through their members' experience accumulation, knowledge articulation, and knowledge codification resulting in a new or improved routine (Zollo & Winter, 2002). Once codified, the new routine can be diffused through the application of ICT for implementation in the organization. As this process is achieved, more organizational learning takes place. Furthermore, this routine is now raw material of a new cycle of organizational learning. In all or part of this development process it is assumed that ICT is supporting the process by representing knowledge for both experience transfer (from employees to management) and routine diffusion (from management to organization). *We want to know if ICT in fact support organizational learning and routine development, and if so, how and under which circumstances*. Thus, we will also look at knowledge management (KM) as a possible source of explanation to the phenomenon.

Our central concept will be based on how the cognitive/behavioral organizational learning theory can support routine development applying computer as a support tool. Figure 1.4 below illustrates a simple organizational learning cycle where we have adapted Levitt & March's (1988) routine development cycle, and incorporated Huber's (1991) organizational memory. We apply knowledge stored in a computer as starting point for execution, and where the accumulated experience is articulated and transferred through the computer. On its way the experience is expected to change to the point where a new routine is diffused. The action of individuals has become organizational (Argyris & Schön, 1996:8).

An organizational learning cycle applying ICT support

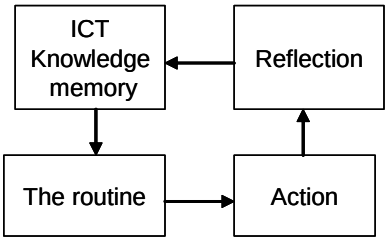


Figure 1.4. A model of an organizational learning cycle

This research starts at the time a new ICT system, a so called knowledge management system, is being developed for the purpose of replacing an old ICT system, a so called document

handling system. While most ICT systems are aiming to improve firm performance, firm performance will not be measured here. Rather, routine development has to do with making operations more efficient and/or effective, and based on that, firm performance may be estimated, although not precisely assessed. Furthermore, through our research we want to follow the process of implementing the new system in order to uncover what impact computers have on routine development, how routines are developed, and under which circumstances such routines got to be developed. Hence, what happened to routine development once the new computer system was implemented? More specifically, what happened to management's routine development strategy? This research thus begins at the time of a planned strategic initiative to improve routine development has been made.

Specific research question can now be framed in relation to the phenomenon of interest. The research questions in this study are:

Can ICT-supported knowledge representation enhance the development of operating routines in business organizations? If so,

How, and under

Which circumstances?

Few academic contributions exist which specifically focus on ICT-represented knowledge as a mediating variable in the pursuit of enhancing routine development. The globalization of industry and markets requires a need to coordinate and locate organizational knowledge, and develop a capability to generate/improve, transfer and apply such knowledge. This suggests the need to understand how computers support routine development. In particular, researchers who have conducted descriptive and longitudinal studies on the phenomenon have raised the issues of how organizational knowledge is shaped by ICT application. While literature discusses the use of ICT for the purpose of enhancing OL, we do not find it discussing routine development related to computer application (Davenport, 1993).

For example, Davenport (1993) discusses innovation of processes based on ICT. His argument is that ICT no longer is expected to improve performance in itself, but only as an enabler for employees. While describing the production area as "the most likely source of innovation and process excellence" (1993:231), Davenport's study do not discuss routine development related to computer application. Also, in their analysis of information system's impact on knowledge creation, Nonaka et al (2001b) argues that such technology can be an engine for knowledge-creating processes. Yet, they are not discussing the process of

organizational learning and routine development. In a study of the role played by IT in strategy formulation, Powell and Dent-Micallef found that “ITs have not, in and of themselves, produced sustained performance advantages (but only through) leveraging complementary human and business resources” (1997:375).

Despite the interest on organizational learning and knowledge creation, seen from the perspective of disciplines such as strategy, production management, management science, organizational development, sociology and culture (Easterby-Smith, 1997), little research on how and why of computer-supported routine development has been accumulated. Due to the lack of existing research on routine development, the study will be explorative. It should nevertheless be possible to gain a better understanding of the computer’s role in organizational learning and thus a better basis on which to conduct this study. Because of the complexity of the phenomenon and indeed of the study, existing research contributes by focusing the study on an area which needs to be explored further. Literature on the various aspects of ICT and organizational learning, particular research on development of routines and the role of ICT, is therefore reviewed. Because of lack of theoretical focus on the issue of routine development and the role of ICT, and because of the sparse and fragmented body of literature on organizational learning, routine development and the role of ICT, the literature review also includes other fields that have studied organizational learning and ICT.

1.5 Summary

We have in this chapter introduce the problem area by describing the research setting, and identified observations made in the field which lead us to research computer-supported organizational learning. Furthermore, we have positioned our work within the cognitive/behavioral organizational learning theories. Then we proceeded to describe the phenomenon under study - development of operating routines within a production organization, and on that basis state the research question.

In chapter *two* we will identify the study’s central concepts and review literature.

2 Central concepts and literature review

From chapter one – the research setting, we have learned that an aluminum company has implemented a new business system – BPS, allowing operating employees, both operators and staff, to participate in the development of the firm's operating routines. Management's intention with BPS has been to achieve improvements to value creation through employee participation in development of operating routine. We will in this chapter start with clarifying the central concepts used in our thesis and define some of the key constructs in the study. The reason for clarifying the central concepts is that the term routine and development of routines is defined in multiple ways. Furthermore, in the literature we find little reference to a discussion of development of operating routine in relation to ICT. Thus, we need to clarify what we mean by development of routines (RD) in relation to these issues. In this chapter we will also review literature on the phenomenon and uncover how similar questions have been dealt with earlier. On this basis we will choose a theoretical venue that is promising to explain the phenomenon under study. We will carry out a critical assessment; point out gaps in the knowledge, and on this basis identifies how these holes can be filled. This will represent our contribution to the knowledge area. Finally, we will also provide an understanding of the boundaries of the study.

2.1 Central concepts

The concept of operating routine and routine development is given scant attention in the literature. We will in this section clarify central concepts used in this thesis by giving a crude description of what we mean by the concept of routine development. There is an intertwined relationship between knowledge, learning, routine development and organizational learning. Furthermore, we see a relationship between routine development and ICT within larger organizations.

Individuals possess knowledge consisting of a relation between concepts. Concepts are linked to each other through several types of relationships, for example hierarchy and implication. What has been learned is stored in individual heads (or data files) as knowledge structure which represents an individual's information world and thus facilitate information processing and decision-making (Walsh, 1995:281). A knowledge structure is a mental template that individuals impose on an information environment to give it form and meaning, and an

individual's knowledge structure orders an information environment in a way that enable subsequent interpretation and action (Walsh, 1995). A person's knowledge is linked to how the person understands things.

Some knowledge can be articulated and represented through oral or written forms (explicit knowledge); other knowledge cannot be articulated (tacit knowledge). Once you have articulated your knowledge, communication with others will be possible. Knowledge that can be explained can also be codified. Declarative knowledge, therefore, can be codified. Codified knowledge can be externalized and presented via artefactual means, such as computers. When you express your opinion you are at the same time presenting your knowledge. Represented knowledge can be residing at the individual, group and firm level (Argyris & Schön, 1996; Huber, 1991).

Coded and represented knowledge is for others data. Data becomes information to those who operates within a given context and have prior knowledge to understand them (Levinthal & March, 1993; Cohen & Levinthal, 1990). Thus, within a firm, context-specific data, such as an operating routine, can be converted to information by those possessing knowledge about the information domain represented by the routine. If the routine adds new data to the receiver's current knowledge, the receiver, in order to understand it, needs to interpret what the new data means. This interpretation is a cognitive learning process, and through this learning the receiver has obtained new knowledge. Learning can be both cognitive and behavioral. Cognitive learning takes place through reflection and/or observations, where one learns from the consequence of an action or thought. Behavioral learning takes place when the action is repetitive, and you are gaining experience by getting better and better at practicing it. Knowledge is based on cognitive and behavioral learning, where one learns from own and others experience and then practice such experience. However, some knowledge cannot be transferred, while some can only be transferred through demonstration. Other knowledge can be made explicit through articulation and codification for example into a computer, or some other artifacts, and thus made available to members of the organization for them to learn. By practicing the new knowledge one may experience potential improvement, for example, to an operating routine.

Routines represent past experience accumulated as a result of positive and negative reinforcement of prior choice (Levitt & March, 1988), and is therefore backward-looking

while “cognition is a forward-looking form of intelligence that is premised on an actor’s beliefs about the linkage between the choice of actions and the subsequent impact of those actions on outcomes” (Gavetti and Levinthal, 2000:113). There may not necessarily be a conflict between the application of experience and cognition in the development of routines, as noted by Fiol and Lyles: “Organizational learning means the process of improving actions through better knowledge and understanding” (1985:803). This is supported by Gavetti and Levinthal arguing that cognitive representation “usefully constrain the directions of subsequent experiential search” (2000:113). Thus, in order for routines to be developed, employees need to both experience from practicing a routine, and reflect on such experience. This cognitive/behavioral iteration is the basis for employees’ articulation of an accumulated experience.

The term routine is defined in multiple ways (Argyris and Schön, 1996; Huber, 1991; Levitt and March, 1988; Cangelosi and Dill, 1965). Levitt and March includes in the term ‘routines’: “*forms, rules, procedures, conventions, strategies, and technologies around which organizations are constructed and through which they operate”* (1988:320). We agree that such various definitions can be applied to our research. However, our focus is not only on routines but on the development of such routines. *Routines* have to do with increasing performance through the exploitation of accumulated experience within the organization, while *Development of Routines* have to do with exploring for better solutions when executing a firms business process. Thus, while exploration takes place before a routine is institutionalized, exploitation takes place through the process of diffusion. Initiative to improve a routine based on experience can come from anywhere in the organization. Provided valuable to the organization, such experience feedback can initiate a development process leading to improving a routine. Hence, this research looks at the development cycle.

Furthermore, our focus is not on any routines but on operating routines. We interpret Kogut and Zander’s (1992) procedural knowledge, as operating routines: “procedural knowledge is a description of what defines current practice inside a firm” (1992:386). That is, operating “practices may consist of how to organize factories, set transfer prices, …” (Kogut and Zander, 1992:387) in the sense that such operating practice can be articulated and codified based on a cognitive/behavioral process (Zollo and Winter, 2002). In this thesis we consider o*perating routines* to include *activities, within production and functional areas, executed by employees participating in producing goods and services*. It excludes all routines not

associated with operations, such as strategic processes, mergers and acquisitions, and corporate finance. Operating routines consists of both procedures and best practice. A p*rocedure* is a step-by-step execution of a task while *best practice* is a recipe containing knowledge of how to execute a task. Argyris and Schön apply program as "procedural descriptions of organizational routines" (1996:16). Combining 'current practice' and 'procedural knowledge' with Levitt and March's phrase "through which they operate" (1988:320), gives us current *best practice routine*. We will in this thesis apply 'routine', 'operating routine' and 'best practice' interchangeable. With 'development of routines' we imply development of operating routines, and such development can imply an improvement to, replacement of, or establishing of a new, routine.

Development of operating routines is tightly linked to organizational learning through an organization's encoding of inferences (Levitt & March, 1988) and stored into organizational memory (Huber, 1991), in ways that will permit it to be recovered when relevant (Walsh, 1995). Building on past experience an organization's mental template is called a knowledge structure because it "represents organizational knowledge about a given concept or type of stimuli. The mental template consists of organized knowledge about an information domain" (Walsh, 1995:281/2). This stored knowledge representation, when externalized, is being interpreted by members of an organization by employing their individual knowledge structures – resulting in organizational learning. Organizational learning is therefore a central theme within our routine development research, and organizations learn through cognitive/behavioral processes (Crossan et al, 1995:340). Finally, our focus is on organizational learning applying knowledge represented through ICT as a support for developing operating routines. Thus, we need a dynamic process implicit in our definition of what a routine development is.

Basing our organizational learning theory on the cognitive/behavioral perspective, we have found it useful to encompass several elements in our search for a definition, as it must also satisfy 'dynamic' and 'ICT' dimensions. According to Huber (1991)

> *An organization learns if any of its units acquires knowledge that it recognizes as potentially useful to the organization. (1991:89).*

Huber recognizes that not all knowledge acquired by any of the organizational members is necessarily useful for the organization. He also recognizes that the organizational learning can be a result of individual members sharing some potential useful experience. The subject of

this thesis is routine development. By building on (borrow from and modify) Huber's characterization of organizational learning (Huber, 1991) we will in this thesis apply the following definition to organizational learning:

- *Learning occurs when any of the members acquires knowledge that may be related to the organization,*
- *More learning occurs when more members obtain this knowledge*
- *More learning occurs when more varied interpretations are developed, and*
- *When more members comprehend such varied interpretation.*

Huber's definition of organizational learning includes the *acquisition* of knowledge either through experience or through import into the organization. It also implies *transfer* of knowledge, both as articulated and codified experience being used as raw material for developing/improving a routine, as well as new routines being diffused into the organization. Furthermore, it emphasizes organizational learning as development of *more varied interpretations*, and that more employees understand such interpretation. However, in order for learning to become organizational such new knowledge needs also to be integrated and adapted at a multilayered structure of individual-group-organizational levels (Cangelosi and Dill, 1965:200). Through adaptation and interpretation the members provide raw material for new routine development (Zollo & Winter, 2002). Thus, to us the central concept is organizational learning - that is, routine development is a consequence of an organization that learns through accumulating experience, articulating such experience through transfer, codifies it into a new routine, and diffuses the new routine to its members. Thus, OL is antecedent to RD.

2.2 Reviewing the field

The field of organizational learning has developed quickly, and diverse, over the last decade or so. While the watershed took place with the special issue of *Organization Science*, February, 1991, the source of organizational learning is based on the writings as far back as John Dewey (1916, 1933, 1938), writing about experiential learning and the need for social interaction; internal resources of the firm and "the dominant role that increasing knowledge plays in economic processes" (Edit Penrose, 1959:77); tacit knowledge (Michael Polanyi, 1962); and situated knowledge (Frederick Hayek, 1945/1949). Due to the fast development of OL theory, authors have taken different tracks, different terminologies, and variations of definitions, resulting in fragmentation and confusion of the field (Easterby-Smith & Lyle, 2003; Vera and Crossan, 2003; Tsang, 1997; Easterby-Smith, 1997).

Different tracks have actually resulted in a field consisting of at least four different concepts: Organizational learning (OL), Learning Organization (LO), Organizational Knowledge (OK), and Knowledge Management (KM). They all overlap, and in trying to make themselves distinct from the other fields end up confusing readers. For example, while *organizational learning* is descriptive and concerned with how organizations actually learn (Cyert and March, 1963; Cangelosi & Dill, 1965; Argyris and Schön, 1986; Levitt and March, 1988; March, 1991; Huber, 1991; Simon, 1991), *learning organization* (Senge, 1990) is prescriptive and concerned with how *should* organizations learn (Tsang, 1997). *Organizational knowledge*, also primarily descriptive, is related to economics and focuses on the importance of knowledge as a firm resource (Penrose, 1959; Polanyi, 1962); of 'tacit' knowledge and routine-learning in operations (Nelson & Winter, 1982; Nonaka and Takeutchi, 1995); and of organizational knowledge and empowerment (Spender, 1996). *Knowledge Management* is prescriptive and concerned with how should organizations manage its stock of knowledge in a most effective and efficient way.

Use of terminology also becomes confusing when "authors such as Nonaka and Takeuchi (1995) argue that *organizational learning* and *knowledge creation* processes are different concepts. Also, while researchers in a field refuse to associate learning with knowledge by failing to acknowledge the other - as when researchers in organizational learning exclude the term 'knowledge' from their studies and researchers in knowledge management do the same with the term 'learning', other researchers use the terms learning, knowledge, and knowledge management interchangeably" (Vera and Crossan, 2003:123). Furthermore, the "related terms 'organizational learning' and 'learning organization' are sometimes used interchangeably" (Tsang, 1997).

The confusion is also a result of focusing on different phenomenological domains, which "do much to explain the lack of convergence among organizational learning frameworks" (Crossan et al, 1999:522). Furthermore, one can review organizational learning from different disciplinary perspectives, such as "psychology and OD; management science; sociology and organizational theory; strategy; production management; and cultural anthropology" (Easterby-Smith, 1997:1085). While Zollo and Winter argues that OL consists of experience accumulation, knowledge articulation and knowledge codification, Huber (1991) examines organizational learning applying four constructs: knowledge acquisition, information

distribution, information interpretation, and organizational memory (1991:88). In spite of all theory on organizational learning, where researchers have presented us with a set of theories that relate learning to the utilization of knowledge, the literature does not identify a convergent view on which constructs that influences the utilization of knowledge or learning can be based (Lyles & Easterby-Smith, 2003:645).

Despite recognition of the importance of organizational learning and the development of more efficient/effective operating routines, much of the literature on organizational learning is conceptual, about academic positioning, and the creation of one's own concepts and perspectives (Easterby-Smith & Lyle, 2003; Vera & Crossan, 2003; Tsang, 2003; Easterby-Smith, 1997). The first and most obvious reason is that it is *simpler* to conceptualize what organizational learning is, and, given the field's young age (Easterby-Smith, 1997), try to give direction of theory. However, such simplicity, while virtuous, does not always enhance the understanding of complex processes. It is being argued in this thesis that to fully understand the process of developing routines, we need to incorporate several elements which current literature has tried to shy away from.

Furthermore, most literature on organizational learning treat learning as *static and stable* over time (Easterby-Smith, 1997), while organizations operating in the global context require dynamic learning capabilities (Zollo & Winter, 2002). Little is being written on the issue relating to how computer-supported knowledge representation can offer *dynamic* learning capabilities. To our knowledge, within production management there exist little empirical knowledge on *how computers supports experience transfer, and the development and implementation of routines; how computer-supported knowledge representation enhances such development; or under which circumstances such development can take place*. Literature on organizational learning gives scant attention to routine development. Research specifically focusing on routine development within an organizational learning context is lacking in terms of theoretical basis.

Another reason little research exists on OL and RD may be tied to the *focus* of existing research on organizational learning. Current research seems to be more concerned with creating a distance between concepts, which we believe are intimated related, rather than attempts at convergence. Yet no business organization can be without such dynamic and holistic approach to its development, and consequently needs to understand how

organizational learning can support RD and productivity. Also, by refusing to associate learning with knowledge, one can create the impression that an organization's ability to learn has nothing to do with the process of developing operating routines (Vera and Crossan, 2003). Yet, in their reference to the book of Cyert and March's (1963), Easterby-Smith and Lyles points out that the book "could perhaps be described as *the* foundation work on organizational learning … (and this proposed general theory of organizational learning) emphasize the role of *rules, procedures* and *routines*" (2003:9).

In an attempt to structure the field, Lyles and Easterby-Smith (2003) have identified four streams of literature on organizational learning (fig. 2.1) which will be briefly summarized and critically evaluated in terms of their respective insights on routine development processes and contributions to the explanation of this thesis. From this review we will consider the perspectives we choose to focus on. Routine development is a management approach to the development of the organization where employees are invited to be part of the organizational development process. Such development can impact both operating processes and strategic norms and goals (Lant and Mezias, 1992:64, in Miller, 1996:500; Nelson & Winter, 1982).

2.2.1 Four directions of organizational learning

According to Easterby-Smith and Lyles (2003), OL have been split in four main directions:

1. The learning organization - prescriptive studies
2. Knowledge management - prescriptive studies
3. Organizational knowledge - descriptive studies
4. Organizational learning - descriptive studies

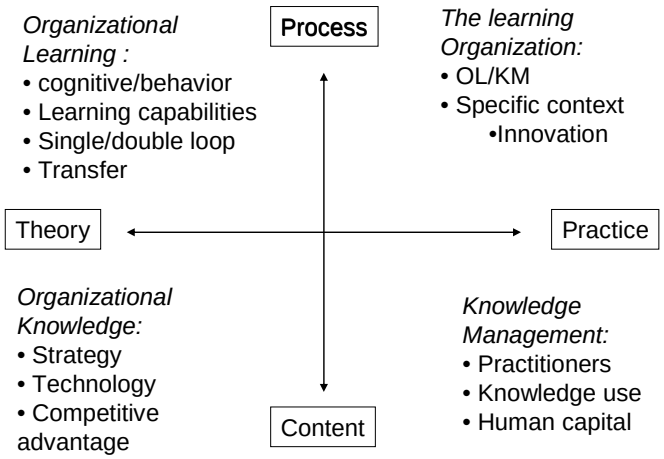


Figure 2.1: Four perspectives of organizational learning Reference: Lyles and Easterby-Smith (2003)

While the first two areas are more of a prescriptive category trying to give practical advises on how an organization learns or which ICT system will best fit a given learning process, the last two are descriptive studies often giving a conceptual reason for studying a certain phenomenon.

The learning organization (LO)

The difference between a learning organization and organizational learning is focus on improving organizational performance vs. theory building. While the first concept is prescriptive and "is concerned with the question 'How *should* an organization learn?' … descriptive researches on organizational learning … tackles the question "how *does* an organization learn" (Tsang, 1997:73. *Italic* original).

In 1988 Ariel DeGeus (1988) asked the question "How does a company learn and adapt"? His question was prompted by the oil industry's volatile behavior, and his discussion with Allan Wilson of Berkeley. In their discussion DeGeus was intrigued by Wilson's explanation of the way some birds are more able to adapt to the environment than others. Furthermore, at MIT a group of executives participated in the Program in System Thinking and New Management Style. Based on this work Peter Senge (1990) wrote The Fifth Discipline, popularizing the Learning Organization. It is a prescription of how to build an organization capable of learning in the sense of planning how to learn. Senge (1990:1) defines a LO as "a place where people

continually expand their capacity of creating results they really want, where patterns of thinking are broadened and nurtured, where collective aspiration is free and where people are continually learning to learn". LO is a prescriptive stream of research focusing on "how *should* an organization learn". The field attracted consultants and managers as it could articulate a formula for success. However, the LO's focus was managers' challenge regarding professional groups' control of knowledge resources and the advance of new technology. On this basis LO focused on how "organizations design themselves to value, manage, and enhance the skills and career development of their people in order to ensure continuous organizational transformation" (Scarbrough & Swan, 2003). The learning organization is not within the scope of this study, nor can we see any theoretical literature relevant for our research topic.

Organizational Knowledge (OK)

Organizational knowledge belongs to the economic sphere of research, focusing on issues relating to a firm's resource base, and is influenced by economists such as Hayek and Penrose. As philosopher, Polanyi (1962) became interested in the nature of organizational knowledge and introduced the distinction between tacit and explicit knowledge. Tacit knowledge, as it is related to a given task execution, is in Polanyi's view "essential ineffability … a set of particulars without being able to identify them … since their practitioners do not ordinarily know what those particulars are" (Tsoukas, 2003:414/5). Thus, Polanyi's point: "we can know more than we can tell" (Polanyi, 1966:4). This work was followed up by Nelson and Winter (1982) focusing on the evolution of knowledge through tacit and explicit knowledge of individuals and organization. Nelson and Winter is also arguing that routines are knowledge capable of both fostering learning that refines existing practices, as well as through the process of innovation itself (1982).

In a series of articles Nonaka (1994) discussed organizational knowledge. In their book, Nonaka and Takeuchi (1995) created the term 'knowledge-creating company'. Again, this was an attempt to develop a theory on how business organizations could design a knowledge-creating strategy. "Any organization that dynamically deals with a changing environment ought not only to process information efficiently but also create information and knowledge" (Nonaka, 1994:14). And, again, OK has primarily a focus on "innovation, which is a key form of organizational knowledge creation" (ibid:14). Nonaka and Takeuchi applied a case to the development of knowledge creation through transformations of tacit and explicit knowledge

in a typhoon like process of a continuous spiral with enhanced knowledge as a product at each cycle (1995:73).

Spender (1996) argued that for firms to succeed in dynamic markets, they had to manage their knowledge assets. “Thus, it is the firm’s knowledge, and its ability to generate knowledge, that lies at the core of a more epistemologically sound theory of the firm” (1996:46). In his attempt to identify what makes firms learn and retain knowledge he makes a critique of Nonaka and Takeuchi’s individual creativity contribution vs. Nelson and Winter’s collective routine development arguing that “both leaves the task uncompleted because while opening up dynamic processes neither deal with the corollary, that there must be some means of closure” (Spender, 1996:59). Spender seems to have chosen OK over OL because “to know is to be able to take part in the process that makes that knowledge meaningful … for it is the performance, especially in the face of unanticipated uncertainties and challenges, that is the true test of executive knowing” (1996:59). Again, the focus is on innovation rather than the improvement of current operating routines.

Trying to build a bridge between learning and knowledge, Vera and Crossan (2003) argues that “Whereas the term learning has not been bound up in questions of veridicality and accuracy, the term knowledge has witnessed many debates” (2003:125). They argue that knowledge can be obtained through the mind, accumulated in the mind and executed as “knowing is practice … (and knowing) is part of action” (2003:126). Learning is change in knowledge and change in knowing. “The main distinction between knowledge and knowing is that knowledge is mainly cognitive, including the facts and the skills we possess, while knowing is mainly behavioral, it is knowledge as action” (2003:126). Thus, knowledge and learning are two sides of the coin. “While learning (the process) produces new knowledge (the content), knowledge impacts future learning” (2005:131).

We agree with Vera and Crossan that the boundary between OK and OL is glassy. However, as we are studying the RD process we will not explore OK further. To the extent that OK should in some ways be included in our OL discussion, it will be regarded as part of organizational leaning theory.

Knowledge management (KM)

Knowledge management involves levering best practice routines internally and externally in an organization and creating a process for valuing the organization's intangible assets (Liebowitz, 2006). Conceptually one can argue that Huber's (1991) application of the use of ICT in organizational learning can be a good starting point for theorizing around KM. We believe KM is a more recent phenomenon (Davenport & Prusak, 2000). KM is primarily a consultancy-driven prescriptive phenomenon focusing on how an organization should effectively manage its store of knowledge. Often anecdotal, there seems to be little theoretical foundation in the KM literature regarding preferences of knowledge management systems as "KM (i.e., to capture, codify, use, and exploit the knowledge and experience of employees by developing better tools and methods) literature focuses mostly at the level of specific KM projects rather than at the level of broader change initiatives" (Scarbrough & Swan, 2003:505. Parenthesis original).

However, when that is said, KM is a concept based on "the neo-economic view of the strategic value of organizational knowledge and then uses familiar IT software such as databases and electronic conferencing to facilitate the acquisition, sharing, storage, retrieval, and utilization of knowledge" (Easterby-Smith & Lyles 2003:12). This puts KM in the category of cognitive science. According to Vera and Crossan they have proposed "the co-alignment between a firm's learning/knowledge strategy as a moderator of the impact of learning and knowledge on performance" (2003:137). One can therefore argue that by linking KM (strategic value) to OL process such "combinative capability" (Almeida et al, 2003:366) may lead to useful exploitation of routine development for the purpose of enhancing performance.

In our project we will try to understand how ICT-supported routine development can enhance a firm's performance. Thus, while we will focus on the process of organizational learning, knowledge management theory will be applied to the extent that management responsibilities are to design processes and implement systems. To the extent that a KM system is a deliberate process by management, it will be part of our discussion. KM systems could also work as knowledge disseminators, enabling problem solving and learning. (See e.g. Apple and Microsoft computers' KM system, which contain anything between How-to manuals and research papers).

Organizational learning (OL)

The last quadrant in Figure 2.1 is organizational learning. It has been described by Tsang as a descriptive research "which tackles the question 'How does an organization learn?' … (and) 'Are academic studies striving for scientific rigor'?" (1997:73). In the next section we will review the literature on organizational learning and routine development.

2.2.2 Organizational learning and development of routines

In recent years what started as a first attempt to understand how organizations learn March and Simon (1958) discussed standardization, coordination, feedback and routinization of activities stored in standard operating procedures. The first to actually discuss organizational learning was Cyert and March (1963), arguing that "Just as adaptations at the individual level depend upon phenomena of the human physiology, organizational adaptation uses individual members of the organization as instruments (for adaptation) at the aggregate level of the organization" (1963:172). Cyert and March argues that, while changes to routines may take place over a long haul, such adaptations seem to be stable in the short term. Building on previous work, Cangelosi and Dill (1965) found that organizational learning is an interaction among three types of stress: (1) OL is stepwise rather than continuous; (2) learning the preference and goals goes hand in hand with learning how to achieve them; (3) separate mechanisms control adaptation at the individual and team level and adaptation at the organizational level (1965:175). Cangelosi and Dill found in their study that changes to routines due to rapid change in the market place, although stepwise, are dynamic in its form, and that "Cyert-March view may better fit an established, secure organization than it does an organization which is developing rapidly and which still fears bankruptcy" (1965:197).

Organizations learn at different organizational levels, where the mechanisms for learning at individual and team levels are different than that of the organization (Cangelosi and Dill, 1965). For an organization to learn we need to know how it learns, and who does the learning. An action carried out by the organization is not possible without individual action, carried out on "behalf of the collectivity, as its agent" (Argyris and Schön, 1996:9). Thus, an agent can be anyone in the organization accumulating experience within a given routine. As the employee learn, then, it may be said that the employee learn for the organization "carrying out on its behalf a process of inquiry that results in a learning product" (1996:11). However, only when the interest of the organization intersect with the interest of the individual, who has accumulated the experience, the organization learn, and feed back to all employees the product as raw material "to shape the future inquiry carried out by individuals" (1996:11).

This “raw material” is in fact the explicit content of organizational maps, memories and programs. Argyris and Schön define program as “procedural descriptions of organizational routines; they include work plans, policies, protocols, guidelines, scripts, and templates. Artifacts such as these describe patterns of activity and serve as guides of future action. (Thus) organizational learning occurs when individuals within an organization experience a problematic situation and inquire into it on the organization’s behalf” (1996:16).

Organizational learning can be said to be dynamic if there is a deliberate process of learning present in the organization (Zollo & Winter, 2002), where new knowledge is being moved through different levels of organization (Crossan et al, 1999; Argyris & Schön, 1996; Cangelosi & Dill, 1965) resulting in an interrelated employee-team-organizational learning structure. Such learning can be evolutionary (Nelson & Winter, 1982); cognitive/behavioral (Zollo& Winter, 2002; Crossan et al, 1999; Argyris & Schön, 1996; March, 1991; Huber, 1991; Cangelosi & Dill, 1965); social/cultural (Cook & Yanow, 1993; Brown & Duguid, 1991); or power based (Cyert and March, 1963). Other organizational learning theories include myopic learning (Levinthal & March, 1993), superstitious learning and competency trap (Levitt & March, 1988).

Huber (1991) views organizational leaning as dynamic processes by arguing that part of the knowledge stored in human memory can be made explicit and thus a basis for developing the organization further. Storage of organizational knowledge in artefactual memory structures, such as computers, is of significant importance in the application of ICT. For the purpose of developing knowledge through the support of ICT we have two challenges, (1) the technical linking of those who know with those who will benefit from that routine and (2) the development of routines applicable to, and integrated by, all of the relevant community members. The first relates to technique, or technical knowledge (Tsoukas, 2003:422) and what Huber calls cognitive maps, media richness and organizational memory (Huber, 1991). Cognitive maps relates to how an employee interpret the information and how information is framed and labeled. Having a unified structure on the information is clearly reducing the uncertainty, and thus multiple interpretations, toward a task (Huber, 1991). Furthermore, Huber argues that organizational memory - being able to store information into, and retrieve from, a computer plays a critical role in organizational learning. With regards to the second challenge, however, not all literature argues for knowledge codification for transfer to other employees. Some literature argues that organizational learning and routine development takes

place through other mechanisms. Routine development can, for example, relate to concepts such as evolutionary, social/cultural learning, and power based, in addition to the cognitive/behavioral theory. Some of these theories do not consider ICT-supported knowledge representation as suitable for transferring experiential knowledge. These theories will be discussed in the next session. The purpose of this discussion is to find the theory that will support our tentative research question and preliminary findings.

2.3 Criteria for choice of literature

From chapter one the research question was: *Can ICT-supported knowledge representation enhance development of routines in business organizations?* Our focus is how to develop and institutionalize operating routines from the experience made by employees. Theories on organizational learning related to routines, are history-dependent and more often than not based on interpretation of the past (Levitt and March, 1988). Theory on tacit knowledge typically argue that knowledge resides in peoples head, is stored in experiential behaviors, and can hardly be explained because "we can know more than we can tell" (Polanyi, 1966, p. 4). Externalized operating routines are part of the organizational knowledge that has been articulated, codified and learned through some activities. Organizations can learn for example through an evolutionary process (Nelson & Winter, 1982), social/cultural processes (Brown & Duguid, 1991; Cook & Yanow, 1993), through execution of power (Cyert & March, 1963), or through a cognitive/behavioral process (Zollo & Winter, 2002; Argyris & Schön, 1996; Huber, 1991; Levitt & March, 1988). We will now discuss these perspectives related to OL: Evolutionary, Social/Cultural, Power based, and Cognitive/Behavioral.

Evolutionary theory

According to the evolutionary theory, organizations' survival and growth patterns differ due to natural selection determined by an evolutionary economic environment (Nelson & Winter, 1982:9). Based on an evolutionary theory Nelson and Winter see a long-term and progressive dynamic process resulting in change of an organization. Such changes can be eruptive or gradual, while stability comes under the term "routine". Routines are viewed as all activities under normal business operation, and can range from "technical routines for producing things, through procedures for hiring and firing, ordering new inventory, or stepping up production of items in high demand, to policies regarding investment, research and development or advertising, and business strategies about production diversification and overseas investment"

(1982:14). Thus, routines can be viewed as low-order procedures or decision rule and a higher-order decision rule or policy (1982:15).

Within an evolutionary theory, routines, both those that are applied regularly through operations and those applied periodically, are also applied to "modify over time various aspects of their operating characteristics" (Nelson & Winter, 1982:17). Such routines are "rule-guides - a hierarchy of decision rules with higher-order procedures which act occasionally to modify lower-order ones" (1982:17). This guide is in fact a firm's search routine to identify routine modifications or new routines, based upon "certain criteria by which to evaluate proposed changes in routines: in virtually all our models the criterion will be anticipated profit" (1982:18). The evolutionary theory determining routine changes are based on a firm-market behavior pattern over time, and thus profitability. The evolutionary process thus relates to an industry's price structure: "the same prices that provide selection feedback also influence the direction of the search. Through the joint action of search and selection, the firms evolve over time, with the condition of the industry in each period bearing the seeds of its condition in the following period" (Nelson & Winter, 1982:19). Prices and profit are the primary selection criteria and thus determines the new or modified routines. In this perspective routine development is not a cognitive reflection of past experience, but a result of management's search and selection rules implanted in operating and strategic routines. Routine development occurs as a result of external signals, converted by management to new/improved operating routines, and imposed on its employees.

Notwithstanding the above, organizations have memory where organization's specific operating knowledge is stored as formal records and in "doing" (1982:99). This is transferred in an explicit or tacit form to individual employees, who receives information and perform the routines on the basis of their sensory capacity and "an ordinary capacity to understand the natural language of written and oral communication in the wider society of which the organization is a part" (1982:101). Thus, the context of organizational knowledge is in the form of (1) files, manuals, computer memories …, (2) physical state of equipment and of the work environment generally …, and (3) "the context of the information possessed by an individual member is established by the information possessed by all other members … (based on) shared experiences in the past" (1982:105).

A final point to be understood about routine development as seen from an evolutionary perspective is *replication* of routines. Its purpose is for a business organization to replicate an existing routine, or a routine implemented on a new technology or production system, across the firm. By transferring experienced employees to a new situation, or a different part of the firm, such person(s) are better able to understand the new situation and deal with it, or support the employees in the other department so that they can learn (1982:120). From an evolutionary standpoint, organizational learning is based on a master-apprentice relationship, at least within the higher-order change. When it comes to moderating existing routines, in addition to written procedures, this will be spread by shared experience "experience that have established the extremely detailed and specific communication system that underlies routine performance" (1982:105). From a perspective of evolutionary theory, organizational learning and routine development is a combination of managerial power based on external and internal forces, communicated as external and tacit knowledge from those who know to those who shall learn.

Nelson and Winter (1982) maintain that routine is a viable concept within the operation of a firm. Furthermore, changes to routines, or the implementation of new routines, are executed through the registration of external and internal forces. These forces are interpreted by management and converted to new or improved operating routines to be implemented by employees. Learning takes place through oral and written communication, while replication is primarily performed through the transfer of experienced employees.

Social/Cultural theories

The social/cultural literature on organizational learning evaluates experience transfer in relation to its tacit and master-apprentice relationship (Cook and Yanow, 1993; Brown and Duguid, 1991). Cook and Yanow argue that organizations learn because organizations act together, as a group: "learning cannot be done by an individual" (1993:378). This is supported by Brown and Duguid who argues that learning takes place in communities of practice, that knowledge-practice separation is unsound (1991:41) and that "it is the actual practices … that determine the success or failure of organizations" (1991:41). In order to learn one need to be part of a group. "The central issue in learning is becoming a practitioner not learning about practice …(in a community) in which knowledge takes on significance" (1991:48). The focus of Brown and Duguid (1991) and Cook and Yanow (1993) is the social/cultural aspect of learning, of which both perspectives argue for a closeness to work activities in order to learn,

and that organizational learning takes place within such local communities. “When a group acquires the know-how associated with its ability to carry out its collective activities that constitutes organizational learning” (Cook & Yanow, 1993:378). Both reject transmission of explicit knowledge for the purpose of learning as it is not meaningfully transferable (Brown and Duguid, 1991:47; Cook and Yanow, 1993:381).

Brown and Duguid, (1991) argues that organizational learning takes place in communities of practice. Furthermore, development of espoused practice takes place by changing memberships within such communities: “through their constant adapting to changing membership and changing circumstances, evolving communities-of-practice are significant sites of innovation” (1991:41). Within the cultural perspective an organization acts together. Organizational learning can only be done in groups, not by individuals (Cook and Yanow, 1993:378). Thus, learning takes place primarily through oral communication and story telling.

Power theory

Power literature argues that management’s exercising power is the method of learning. The theory of the firm accept management’s power vested in it by the owner(s) to execute a business firm’s goals, and to hire employees to carry out such goals on behalf of management. According to Cyert and March (1963) such goals are achieved through applications of rules reflecting “organizational learning processes by which the firm adapts to its environment” (1963:99). It is the choice by management to control the execution of such rules through standard operating procedures developed by them. “Having previously endowed an organization with goals … we have now completed the portrait with a learned set of behavior rules - the standard operating procedures. These rules are the focus of control within the firm; they are the result of a long-run adaptive process by which the firm learns; they are the short-run focus for decision making within the organization” (1963:134). Learning as an exchange for economic compensation is thus learning by power.

Cyert and March, (1963) identify managerial power through the process of remuneration as the source of organizational learning. Decision rules maintain the pressure from management to have the employees carry out the appropriate routines in exchange of compensation. Routine development is done in a symbiosis between experience made where the experience is a result of management observing an activity, and management’s decision to alter the routines.

Cognitive/Behavioral theories

Part of the literature argues that knowledge and learning is the competitive advantage of globalization, and that such capabilities ought to lead to dynamic improvement in performance. In view of a more dynamic world, therefore, a need to understand the dynamics of routine development is required. Such dynamics can be achieved through a cognitive-behavioral process where experience accumulation is being subjected to knowledge articulation. Such experience-based learning may lead to exploring a possible improvement in the way a routine is being executed (Argyris & Schon, 1978:323), while application of cognitive processes may secure the organization with a balance between utilizing current routines and developing new ones (March, 1991). Thus, cognitive/behavioral processes support dynamic development of routines.

From the above we can conclude that organizations may develop routines through cognitive/behavioral learning processes; and that methodical processes through deliberate organizational learning can lead to dynamic capabilities. Such routine development is the result of a reiteration process within teams, and between employees and management, supported by a computer system.

Within the concept of cognitive/behavioral learning the antecedent to routine development is organizational learning, thus organizational learning literature is a natural candidate for review. Furthermore, organizational learning is assumed to occur through an organization's application of routine, based on individuals' cognitive and behavioral learning. In addition, this thesis explores routine development through computer-supported knowledge representation. However, with the exception of knowledge management literature, which is partly anecdotal and partly cognitive (Crossan et al, 1999), we have not identified relevant literature in relation to routine development and the application of ICT.

Should employees' knowledge remain tacit and not be made explicit, transfer of best practice routine within an organization would be slow, take long time, and be uncertain as to the outcome (Kogut and Zander, 1992). Unless management has as its vision to promote an attitude and structure of organizational learning, systematic routine development will not follow (Zollo and Winter, 2002; Grant, 1996; Argyris, 1977). Without the possibility for sharing, transferring, and applying knowledge the firm will not be able to develop an

integrated routine development mechanism for longer-term performance advantages (Orlikowski, 2000; Powell and Dent-Micallef, 1997;).

Argyris and Schön (1996) maintain that routine development is based on experience submitted by employees, and that learning takes place in a single or double loop, the first being a moderation to a current routine and the second changes to a strategic process. Furthermore, transfer of knowledge relates also to current knowledge base of the actors, both with regard to absorption of knowledge (Cohen and Levinthal, 1990), and application of technology for the purpose of sharing, transferring and applying knowledge (Zollo & Winter, 2002; Orlikowski, 2000).

Summary of the learning literature

The *evolutionary* perspective puts market as the change agent for routine development. This view is not supported by our findings, as management has made a strategic decision to have its employees participate in the development of the firm's operating process through routine development. This strategy, therefore, also exclude the use of *power* perspective as our preliminary findings indicate that the management strategy is working. The *social/cultural* perspective, on the other hand, may have some validity, as it is clear that employees learn by observing others, or that a new employee is influenced by the way the company is doing things. However, our focus is on what happens when experienced employees are accumulating experience or confronted with a new routine down-loaded on a computer. In other words, we are seeking answers to whether or not ICT-supported knowledge representation can enhance routine development. Thus, we will apply the *cognitive/behavioral* concept within the development of routines.

2.4 A cognitive/behavioral perspective on development of routines

When organizations learn, one encodes individuals', or a collection of individuals', experience into a routine for others to acquire such knowledge. When an organization determines to establish a method of feedback (March and Simon, 1958:160), and that feedback is being encoded into a routine to be transferred to the users for the purpose of improving performance, then, barring various imperfections of organizational learning (Levinthal and March, 1993), routine development has taken place. Such lessons, stored in the organizational memory, are important sources of represented knowledge for employees to draw upon. "No learning can take place in an organization unless it possesses a proper

memory system" (Tsang, 1997:83). Thus, in order for an organization to learn, it needs to establish an organizational memory, defined as "stored information from the organization's history that can be brought to bear on present decisions" (Walsh and Ungson, 1991:61). Such information can be encoded in both employees' head and artifacts, and emerges as a result of shared interpretations (ibid:61).

Based on what an organization do - "acting, thinking, knowing, and remembering" (Argyris & Schön, 1996:8), organizational learning is both cognitive and behavioral activities. Hence, our choice of definition will be confined to those containing cognitive/behavioral activities, leading to a "change in potential behavior" as the determination of actual change in what has been learned may be difficult to prove (Tsang, 1997). We will identify five articles presenting their definitions of organizational learning, using a cognitive/behavioral orientation:

1. Argyris and Schön (1996:3/4)
    - Generically: an organization may be said to learn when it aquires information (knowledge, understanding, know-how, techniques, or practice) of any kind and by whatever means.
    - Specific: Organizational learning consists in an organization's improvement of its task performance over time.
2. Cangelosi and Dill (1965:200)
    - Organizational learning must be viewed as a series of interactions between adaptation at the individual or subgroup level and adaptation at the organizational level.
    - Routine development is a continuing accumulation of rules or standard operating procedures for making decisions or taking action (194).
3. Huber (1991:89) (modified)
    - Learning occurs when any of the members acquires knowledge that may be related to the organization
    - More learning occurs when more members obtain this knowledge
    - More learning occurs when more varied interpretations are developed, and
    - When more members comprehend such varied interpretation.
4. Levitt and March (1988:319)
    - Organizations are seen as learning by encoding inferences from history into routines that guide behavior.

5. Fiol and Lyles (1985):
    - Learning: The development of insights, knowledge, and associations between past actions, the effectiveness of those actions, and future actions.
    - Adaptation: the ability to make incremental adjustments as a result of environmental changes, goal structure changes, or other changes.

In their article from 1995, Crossan et al summarized a group of influential papers on organizational learning (1995:340). The selected five papers relating to our list of chosen definitions is copied from Crossan et al and can be seen in Table 1 below:

Table 1
Summary of Influential Papers

Author	Level; Individual (I,i), Group (G,g), Organization (O,o) (Upper Case – dominant)	Cognition (C,c) Behavior (B,b) Orientation (Upper Case – dominant)	Learning-Performance Link (L ~› P indirect link L → P direct link)
Argyris (1977; 1976; 1967)	**I–g–o** "Organizations learn through individuals acting as agents for them." However, groups/teams and organizations are facilitators or inhibitors of learning.	**C–B** Learning is error detection (cognition) and correction (behavior). Single loop learning is learning *within* a frame of reference or paradigm, and double loop learning is learning a new frame of reference or paradigm.	**L ~> P** Performance is the outcome of education/learning. Learning can be effective or ineffective, depending on the theory of action (single or double loop).
Cangelosi Dill (1965)	**i–g–O** "Organizational learning must be viewed as a series of interactions between adaptation at the individual or subgroup level and adaptation at the organizational level." There is more emphasis on the group and organizational levels than on individuals.	**c–B** Learning is adaptation or a change in behavior. Changes in behavior demonstrated that an organization had learned. Cognition could play a role in elevating stress, which motivates behavior, but it is not specified or emphasized.	**L → P** Learning is improved performance in order to reduce divergence and conflict in goals and in outcomes of activity.
Huber (1991)	**i–g–O** An information processing perspective that can be applied at individual, group, organizational, industry, or society levels of analysis. Focuses on individual interpretation but relates it to an organizational level.	**C–b** A behavioral perspective that the author specifically contrasts with a cognitive perspective: "An entity learns if, through its processing of information, the range of its potential behaviors is changed. " Change resulting from learning need not be visibly behavioral.	**L ~> P** "Learning does not have to be conscious or intentional. Learning does not always increase effectiveness or potential effectiveness. Entities can incorrectly learn and learn correctly things which are incorrect."

Levitt March (1988)	**O** Organizations learn "by encoding inferences from history into routines that guide behavior." Routines include forms, rules procedures, conventions, strategies, and technologies.	**C–b** Cognitively focused with an emphasis on encoding learning into routines that guide behavior. Problems in the learning process result from "inadequacies of human cognitive habits," as well as from organizational features.	**L ~> P** "Learning does not always lead to intelligent behavior." There also are competency traps, superstitious learning, and erroneous inferences.
Fiol Lyles (1985)	**i–O** "Organizational learning is not simply the sum of each member's learning." Organizations develop and maintain learning systems, and learning is influenced by contextual factors such as organizational culture, strategy, structure, and systems. Group level learning is not addressed.	**C–b** Learning (cognition) is distinguished from adaptation (behavior). Learning is "the development of insights, knowledge, and associations between past actions, the effectiveness of those actions, and future actions." Adaptation is "the ability to make incremental changes, goal structure changes, or other changes."	**lower L → P** **higher L ~> P** Lower level learning (not referring to level of the organization) is performance (and behaviorally) oriented. Higher level learning adjusts overall rules and norms rather than activities or behavior (and is more cognitively oriented).

We want to focus our research on routine development within a cognitive/behavioral perspective of organizational learning. Our focus, while it is routine development at two plant-specific organizational units, is related to a learning process encompassing multiple organizational levels which may include a single employee, team/business unit (plant) and organizational level, and where RD is based on an oral or written dialogue between these levels. Furthermore, we want to see the effect of computer-supported knowledge representation on the development of routines. Finally, in a turbulent environment we want to understand how a production organization is capable of renewing their organizational knowledge through RD.

In synthesizing the above articles we have identify areas where we would like to make a contribution. All articles recognize the cognitive/behavioral learning theories. We consider these theories as the basis for our work. Only through the possibility to both recognize an experience having been made and being able to apply that experience is it, in our view, possible to share such knowledge through articulation and codification. On the learning-performance link we agree with those arguing that some learning may not improve performance. Thus, our case recognize the indirect learning-performance link by arguing that regardless of how much employees can influence a new routine, in order to avoid such concepts as myopic learning management must be responsible for instituting new or improved operating routines.

Our contribution will be primarily at the level of the learning process listed in table 1, column 2, as individual, group, organization. While three of the articles listed in table 1 recognize that learning takes place at multilevel, Levitt and March (1988) consider organizational learning only to take place at the level of organization, while Fiol and Lyles (1985) argues for individual and organizational levels. Our preliminary analysis has clearly identified a multilayer organizational learning structure at the individual, team/group and organization levels.

Huber (1991) identifies an information processing perspective leaving the institutionalization of organizational learning to the organization. Through organizational memory employees can find out which organizational knowledge the firm possesses. He recognizes computers as carrier of institutionalized knowledge, conceptualizing that as more members of the organization acquire this knowledge organizational learning takes place. Furthermore, as more varied interpretation is developed, new knowledge is created. From this one can subsume that Huber (1991) consider use of computer for storing organizational knowledge as a mean to enhance knowledge development.

Multilevel deliberate organizational learning within a cognitive/behavioral perspective

Within the cognitive/behavioral perspective we find Huber's (1991) organizational learning theory to give most explanatory power to our research. This is due to the fact that our primary concern is how computers can support development of routines. On this basis we will explore two learning concepts to give explanation to how the organization under investigation develops and institutionalize routines. The two concepts are deliberate organizational learning and multilevel learning.

A strategy of deliberate organizational learning requires organizational action to engage employees in the development of routines. Deliberate organizational learning can be defined as *"a learned and stable pattern of collective activity through which the organization systematically generates and modifies its operating routines in pursuit of improved effectiveness"* (Zollo & Winter, 2002:340). In view of a strategic decision by the investigating company to introduce a new computer-based business system, we chose the deliberate organizational learning theory as our venue on development of operating routines. However, while Zollo and Winter (2002) developed their theory based on routine development being subjected to an evolutionary process, we want to focus on the cognitive/behavioral theory for

routine development. Furthermore, while Zollo and Winter barely alluded to the fact that such process can be supported by computers (2002:342), they did not test it empirically. We will argue that computers used to both diffuse routines for implementation in the organization, and for transferring articulated experience back to process owner, can be related to deliberate organizational learning and dynamic capabilities. However, additional theories need to be applied in order to give explanatory power to an effective application of ICT. One such theory is multilevel organizational learning.

Multilevel organizational learning was identified by Cangelosi and Dill (1965), where learning processes differed between the levels of organizations. Crossan et al (1999) elaborate on the multilevel learning process arguing for a sequential process with feedback loops (1999:526), while "appreciating the iterative nature of the processes" (1999:530). We find no strong theoretical deduction in their article of either feedback loops or iterative exchanges of experience. However, we found in our preliminary analysis statements by management focusing on multilevel learning. It is through dialogue between employees and management that new or improved routines will be institutionalized, according to our informants. Thus, while an employee articulate accumulated experience, group, and management, supplies additional knowledge. Preliminary analysis of our research identifies the presence of multiple learning through nested iteration. In chapter 3 - theory, we will focus not only on the necessity for multilevel learning, but will argue that multilevel learning is both nested and iterative.

According to Cyert & March (1963), the cognitive perspective when managing an organization focuses on management as the information source. However, in order to have a nested and iterative process related to development of routines, we need to bring in the behavioral perspective. Thus, while the cognitive perspective focuses on management as the information source, the experience-based (behavioral) theory focuses on employees as a source of knowledge. The deliberate learning process, combining the cognitive/behavioral theories reflects a symbiosis between management and employees. However, in order for employees to participate in the development process, they must be given power to do so. This is where empowerment can be an explanatory factor. According to Thorsrud & Emery (1969) participating in the process of routine development results from empowerment. In order for an employee to apply a computer system, such system must be in place. Furthermore, management must have deliberately designed the system for use by employees at large, and institutionalized the process of employee - management dialogue, in order for employees to

apply the system. While having been given power to participate, and that the system is institutionalized, may still make employees reluctant to apply the computer system due to asymmetry between the interests of the IT-project and the user group. From the theory of systemic innovation (Grønhaug & Kolltveit, 2005) we have learned that neglecting to invite employees to participate in the development of computer systems may make them reluctant to use such systems. According to systemic innovation theory there is a difference in the use of a system between those who participate in its development and those who do not participate. Thus, while multilevel, nested, deliberate organizational learning can explain something about why computers can support routine development, empowerment and system innovation may explain why employees participate in such development processes.

In addition to empowerment and systemic innovation, knowledge management system can to some degree explain the difference in using the two systems. Finally, we will in the next chapter also investigate the single loop/double loop learning. We have been able to identify two types of routine development taking place in the investigating organization: one type is related to current processes while the other relates to changing current strategy (Argyris & Schön, 1996).

Contribution

Focusing on the cognitive/behavioral theory we want to find out if, and how, a deliberate learning perspective can support the application of ICT in relation to routine development. The study will include the implementation of a computer-supported business system for the purpose of accumulating experience, and articulating and codifying knowledge for the purpose of developing routines. The *boundary* of this study is thus ICT-supported organizational leaning in an individual-team-organization relationship leading to routine development applied within a production organization.

Our preliminary analysis suggests that ICT-supported knowledge representation can support an organization's routine development process. Furthermore, the study indicates how routines are both developed and institutionalized. Thus, our contribution will be to add to current knowledge by identifying how computers can support employees in their routine development process, and why employees choose to participate in such activities. We will also be able to describe how codified experience is institutionalized. Explanatory factors as to how routines are being developed supported by ICT will be deducted from the discussion of the literature

review in this chapter. On this basis we will identify possible models leading to the understanding of how routines are developed through the application of ICT.

2.5 Summary

We have in this chapter reviewed literature on organizational leaning and routine development. While organizational learning literature has diverged into additional fields such as learning organization, knowledge management, and organizational knowledge, we will be focusing primary on organizational learning, where we will apply a cognitive/behavioral perspective. Such perspective will give us a focus on the learning mechanisms of experience accumulation, knowledge articulation and codification; experience transfer; and institutionalization of operating routines; supported by computers. Our research is concerned with both the process of routine development and the application of computer to support the development of routines. However, throughout our search of literature we have found little empirical work on combining organizational learning with a computer-supported knowledge representation system. From our literature search, therefore, our questions seem to have gone mostly unanswered. Such research need to recognize employees' ability to both learn through the application of computers and contribute to development of routines.

In this research, being a theory-building case study, our challenge is to improve theories applied in relation to our findings. Based on the cognitive/behavioral perspective we will in the next chapter - Theory, explore the following theories for explanatory power: deliberate organizational learning and multilevel learning with focus on nested iteration. However, we will also investigate the following concepts: single/double loop learning, knowledge management, empowerment and systemic innovation. On this basis we will develop a theoretical model. As these concepts are identified in our research we want to investigate to what extent they impact on the computer supported development of operating routines. This we will do by observing from our case if, under such conditions, routine development has taken place. Our purpose in this research is to contribute to current theoretical basis by improving the understanding of how routines are developed through the application of ICT-supported knowledge representation. But, given that theory on deliberate learning and ICT is in its infancy, and thus highly exploratory, we will keep an open mind before concluding with a possible proposition. Our contribution will therefore first and foremost be to present empirical evidence which may shed further light on the research question.

3 Theory

A tentative research model is developed based on the literature review. The purpose of developing a tentative research model in an explorative study is to draw on existing research as much as possible and to guide data collection. This is in accordance with Zaltman, Pinson, and Angelmar (1973) who argue that researchers rarely start off with an empty head, and even in exploratory studies researchers have hunches. In this study, the tentative model facilitated the early phases of data analysis, but as the analysis proceeded additional literatures had to be introduced. The tentative nature of the model actually indicates that the model is expected to need further development based on empirical findings and, if necessary, additional literatures. Thus, we will in chapter six - discussion, develop a model reflecting our findings.

In this chapter a tentative research perspective on development of routines will be presented. This research perspective is a presentation of the research questions of interest in this thesis, and the perspective is deduced from our literature reviewed. At present the research model is highly deductive and based primarily on theoretical work. However, the perspective served as guidance during data collection as well as during the analysis of the empirical findings. Before the research perspective is presented, there will first of all be a discussion of relevant theoretical perspectives which can be used as a foundation for analyzing the empirical data presented later in this thesis. An assumption underlying organizational learning is to gather accumulated experience, i.e. feedback, based on the current application of routines, and if this feedback is used to do corrective actions to the routine, learning in the organization has taken place. Furthermore, if organizational learning lead to an employee's feedback being used to do corrective actions to the routine, then routine development has taken place. Finally, if such feedback of experience, and replication of new routine into the organization, is supported by computer software, then routine development takes place though ICT-supported knowledge representation.

The OL perspective will be discussed as a relevant perspective for analyzing the data. However, to understand routine development through the support of computers more theories than the organizational learning perspective is required. As the discussion will prove, for the purpose of this thesis as well as from preliminary analysis of the data, a deliberate learning perspective will be introduced in order to understand what influence how organizations

develop routines through the support of information and communication technology. One can view routine development as a continuing cycle.

We will draw from theories described in chapter two. For example, from Zollo and Winter (2002) we will apply the deliberate learning process and dynamic capabilities while leave out their evolutionary and cost discussions. We will apply Levitt and March's (1988) *organizational learning-routine development cycle*, and Huber's (1991) organizational learning and *computer memory* theory. Crossan et al (1999) has presented a theory on *multilevel* organizational learning encompassing individual, group and organizational levels, and which is an important element in understanding the hierarchical learning process. We will also apply Argyris and Schön's (1996) *single loop/double loop* learning theory, while recognizing the fact that this theory is controversial (Espedal, 2003). Argyris and Schön (1991) argues that managing against targets, what constitutes a goal for a sub-unit (single loop) is only a mean to reach a larger goal for an organizational level higher up in the hierarchy (double loop). To the extent that our case could differentiate between a single loop and a double loop learning process it is that any adjustments to a business unit's routine is a single loop and any adjustment to the organization's strategic goal is a double loop learning process. For Zollo and Winter, routine adjustment is incremental if the adjustment only relate to a local operating unit while it is deliberate if such adjustment is a result of a deliberate learning process, impacting a larger part of the company (2002:341).

Furthermore, the preliminary analysis of our case study identifies a closely nested relationship between organizational layers, supported by a deliberate organizational routine development structure instigated by management. Also, our preliminary findings suggest that there is an interaction taking place between the organizational layers, an interaction resulting form a particular organizational practice called empowerment and developed over time in HAL. In addition we found nested iteration, systemic innovation and knowledge management system as possible explanation on our results.

While Levitt and March (1988) discuss nestednes they do not include a mutually dependent iterative dialogue between levels or employees. Empowerment is the other mechanism we want to apply in order to strengthen the applied theories. According to Thorsrud and Emery (1969) it is not enough to be told to use a system, such as BPS, for participating in routine development, they must also be empowered to do so. We believe that both Zollo and Winter

(2002) and Crossan et al (1999) can benefit from enlarging their theories by the nested iteration, empowerment, and systemic innovation concepts. Within this view routine development can be seen as iterative processes, sometime as a result of lower-level initiatives and sometime through strategic change, but always through a nested dialogue between organizational groups and levels. These will be the theoretical basis from which we will evaluate and discuss our findings.

3.1 Theoretical perspective on organizational learning

While organizational learning is a framework for our theory building, we need to start with the cognitive/behavioral learning basis. Codified knowledge, stored in an organizational memory and represented through some artefactual mean, can be learned. By expressing an opinion, experience or other forms of knowledge, one articulates beliefs (Walsh, 1996). This, then, can be codified. The full or partial understanding of the codified message, represented by symbols, depends on the prior knowledge possessed by the receiver. Such represented knowledge can reside at the individual, group or organizational level. While it is routine development which is the focus of our research, we will in this thesis discuss, at the levels of individual, team/group, and organization, the basis for a deliberate OL theory. As pointed out above, for our informants to be prepared to participate in development of routines, we need to ensure that BPS in fact supports organizational learning. The critique toward the stream of literature applied is that it is primarily conceptual. Individuals and organizational groups cannot be treated as rational beings, but must be seen as being influenced by the context one operates in, as well as how they make sense of the reality (Levinthal and March, 1993).

Our central assumption in this study is that *organizational learning* leads to *improved routines* as identified by Levitt and March (1988); that Huber's (1991) organizational memory results in the organization learning new routines through *computer technology*; that by getting access to routines, any employee can participate in the development of new routines impacting at the *single/double loop* level of learning; and that such participation is an organizational process. Based on the view that knowledge codification facilitates the diffusion of existing knowledge (Zollo & Winter, 2002:342), we argue that the principal benefit to the deliberate organizational learning process is seen as coming from the successful use of computer tools. Furthermore, while Zollo and Winter barely alluded to the fact that such process can be supported by computers (2002:342), they did not test it empirically. Thus,

a deliberate organizational learning process will benefit from the application of computer tools in order to develop and diffuse new organizational knowledge.

While Zollo and Winter (2002) developed their theory based on routine development being subjected to an evolutionary process (ibid:339), we want to focus on the *cognitive/behavioral* theory for routine development. Our case demonstrates that the development of operating routines can be enhanced through the application of a *computer-based deliberate organizational learning model* within the cognitive-behavioral theory. Furthermore, our case also identifies a *multilevel nested iterative* structure as a contributing mechanism for successful conversion of accumulated experience into new organizational knowledge. That is, employee-management computer-supported communication may succeed in developing operating routines given a multilayer nested iterative organization structure. Furthermore, a deliberate learning process, we will argue, can be both local and global. The question is not if an experience can be applied throughout the organization, but whether or not an accumulated experience is being articulated and codified into an official routine, or if the experience remains tacit within the individual or team.

A critical element for RD to succeed, therefore, is an *enabling management* policy and practice, which "constitute the firm's systematic methods for modifying operating routines" (Zollo & Winter, 2002:340). Another critical element is *any members'* ability to learn for the organization through processes of inquiry, leading to changes in routines as well as norms (Argyris & Schön, 1996:11). Methods instigating changes to routines and norms are both organizational and technological in nature. In a knowledge focused organization, firms learn new skills by recombining their current capabilities through the cooperation among employees within organizations (Kogut & Zander, 1992). Such recombination can be said to be a product of an iterative process. Finally, for employees to share their experience conditions must be present to make them feel *empowered* to participate, and that the system to be applied has been *designed* on the users' premises.

We will in this chapter discuss deliberate and multilevel organizational learning, empowerment, nested *iteration*, system innovation, knowledge management systems and *single/double loop* learning.

3.2 Computer-supported development of routines

Hydro Aluminium (HAL), the integrated aluminum company we are studying, decided in early 2000 to replace a document handling system, called SDOCS, with a knowledge management type system called Best Practice System (BPS). We will be limiting our study to finding out if routines presented to employees through the support of ICT can be the raw material required for developing new routines, how the system supports such development and under which conditions it happens. We will therefore find out:

- To what extent experience is shared among employees;
- How and why such knowledge is articulated and codified;
- If computer system can support the transfer process and thus
    - provide raw materials for improving a routine,
    - diffuse the new routine through the computer system,
    - for the purpose of learning;
- Employees differ in their views on "SDOCS" versus the new system "BPS".

Based on these findings we will be in a position to critique theories suggested by Zollo and Winter (2002), Huber (1991), and Crossan et al (1999), which can lead to development of operating routines. Furthermore, we want to know which requirements must be presented for ICT to support routine development, and if ICT can support both single and double lop routine development (Argyris & Schön, 1996). On this basis we will discuss possible findings and suggest additions for theory building.

3.2.1 Organizational learning

We will in this section discuss Zollo and Winter's (2002) learning mechanisms and dynamic capabilities, Crossan's et al (1999) hierarchical organizational learning, and Argyris and Schön's (1996) single and double loop learning, applied through an organization's memory (Huber, 1991) in relation to routine development. Then we will go on to the concepts of nested iteration, empowerment, and system innovation.

Routine development cycle

We will start the discussion of our theory with an organizational learning model based on the theory of Levitt and March (1988) where the issue is to convert experience into a routine:

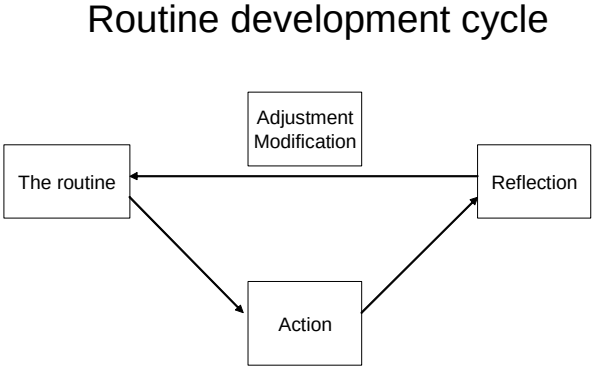


Figure 3.1: Routine development cycle (Levitt and March, 1988)

According to Levitt and March "organizations are seen as learning by encoding inferences from history into routines that guide behavior" (1988:319). We can assume from figure 3.1 that organizational learning is antecedent to routine development; that RD is a consequence of OL; and that the end product is a new routine. In this thesis we will focus on OL in relation to RD. Thus, other forms of learning, such as competency trap (1988:322), storytelling (324), or superstitious learning (325) will not be discussed.

We believe that operating routines are important for organizations to exploit previously explored knowledge (March, 1991). Repetitive actions lead to accumulated experience through behavioral learning (Walsh, 1995), and as the experience accumulate, knowledge becomes increasing tacit. Such repetitive actions may lead to conservation of seemingly well functioning routines (Zollo & Winter, 2002), or that lessons of experience are maintained and incrementally accumulated within a current routine (Levitt and March, 1988). Such tacit accumulation of experience, in a context where internal and external conditions are subject to rapid changes, quickly becomes hazardous if one persists in keeping the same operating routines (Zollo & Winter, 2002:341). Large and complex organizations cannot rely on tacit accumulation of experience to be transferred on a "face-to-face contact (as) individuals need external references to guide their private adjustments" (Argyris & Schön, 1996:16). Thus, large and complex organizations need to have an active policy for deliberate change effort of routines (Zollo & Winter, 2002), requiring a routine development at a multilevel learning process (Crossan et al, 1999) and a means to transfer such changes to the users (Huber, 1991). We will discuss the deliberate organizational learning concept before we continue with a

discussion of multilevel learning, single/double loop learning, organizational memory, nested iterative learning, empowerment, and systemic innovation.

Deliberate learning

Within the context of OL, deliberate learning is an emergent perspective on routine development. A deliberate organizational learning strategy implies establishing a model of the knowledge cycle for the development of operating routines in a context where "competitive conditions are subject to rapid changes" (Zollo & Winter, 2002:341). Its focus is on how "the organization systematically generates and modifies its operating routines in pursuit of improved effectiveness" (ibid: 340). Such a perspective suggests that if an organization instigates a deliberate organizational learning model, the organization acquires dynamic capabilities. Dynamic capabilities are achieved through linking experience accumulation, knowledge articulation and codification in a deliberate act of "routinized activities directed to the development and adaptation of operating routines" (2002:339). We will apply this theory by referring to it as a *deliberate learning* theory.

Through the *experience accumulation* process organizational knowledge becomes increasingly explicit as implicit knowledge is *articulated* through collective dialogue, and that this articulation can be formulated through *codification* (Zollo and Winter, 2002:341/342). Through the codification process diffusion of knowledge can take place, and as such can "contribute new (raw) information" (2002:344) to a new routine development cycle. On this basis Zollo and Winter (2002) argues that "exploitation can prime exploration" (2002:344) and thus balancing the twin problem (March, 1991).

Dynamic capability, then, is the cognitive/behavioral processes of learning how to articulate and codify knowledge on a "continuing interaction and mutual adjustment basis" (Zollo & Winter, 2002:344). By structuring this capability into a deliberate learning model installed in a knowledge system, such as "a piece of software (which) the team has to decide how to update, and then do it" (2002:345), management is able to facilitate the learning mechanism through an "investment in deliberate learning activities" (2002:345).

Through the deliberate learning mechanism two categories of routines will be implemented, one for learning to execute known procedures related to current profit, the other for "seeking to bring about desirable changes in the existing set of operating - in this case production -

routines for the purpose of enhancing profit in the future" (Zollo & Winter, 2002:340). Such a deliberate learning system represents "the firm's systematic methods for modifying operating routines" (ibid:340). The capability inherent in the deliberate learning theory, thus, is an organizational ability to routinize the development of operating routines by providing a structure to improve/alter routines. One achieves a deliberate learning process, according to Zollo and Winter, by combining cognitive and behavioral theories. By externalizing accumulated experience through a deliberate process of knowledge articulation and codification, one develops dynamic capabilities (fig. 3.2).

While Zollo and Winter (2002) links the deliberate learning process to the evolution process, our intention is to apply the deliberate learning process to the cognitive/behavioral theory. This will secure that accumulated experience is being formulated through nested iteration, with a final approval by management before institutionalization. Such institutionalization is important in order to avoid unwanted learning such as myopic. With Huber's technical view on OL, we will ask how, and under which circumstances, experience accumulation, knowledge articulation, codification, transfer and implementation takes place within the knowledge cycle using computers as a support tool for routine development. While Zollo and Winter barely alluded to the fact that such process can be supported by computers (2002:342), they did not test it empirically. Being primarily conceptual we need to find out if a deliberate learning theory can be empirically evaluated. What is missing in Zollo and Winter's (2002) deliberate learning theory is to empirically test how routines are created and institutionalized within the cognitive/behavioral theory.

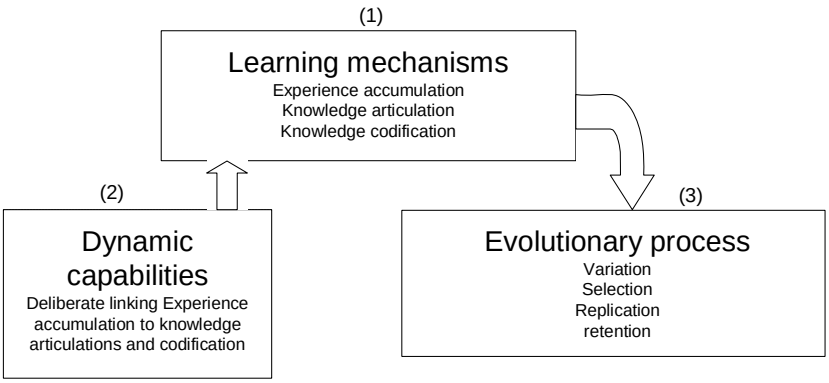


Figure 3.2. Evolutionary based deliberate organizational learning cycle.

Source: Zollo and Winter, 2002.

Figure 3.2 starts out with the (1) learning mechanisms, proceed to incorporate a deliberate learning process referred to as (2) dynamic capabilities, and through steps 1 and 2 the organization achieve (3) evolutionary process. We will not be applying the model's step 3, as our preliminary data identifies an iterative and nested organizational learning process.

Below we will identify the elements going into the deliberate learning process as they relates to our preliminary findings. The first element in the deliberate learning concept is the learning mechanisms. It consists of experience accumulation, knowledge articulation and knowledge codification.

Learning mechanisms

1. Operating Routines and Experience Accumulation

According to Zollo and Winter there are two types of routines: (1) execution of known procedures for the purpose of generating current revenue and profit leading to incremental adjustments, also called operating routines, and (2) routines which seeks to bring desirable changes in the existing set of operating routines for the purpose of enhancing profit in the future (2002:341). Operating routines are *"stable patterns of behavior that characterizes organizational reactions to variegate, internal or external stimuli"* (Zollo and Winter, 2002:340).

While the first type supports a un-dynamic environment, with stable, or slowly changing, routines, routines of the second type relates to environments in rapid change *"due to technology, regulative and competitive conditions"* (2002:341). Furthermore, this second type relates to a deliberate organizational process for the purpose of searching for improving operating conditions *"invoking mechanisms that go beyond semi-automatic stimulus-response processes and tacit accumulation of experience"* (2002:341). Such routines are "*constitutive of dynamic capabilities"* (2002:341). We consider HAL's operational environment to be dynamic and BPS to be a mechanism supporting a deliberate learning process.

2. Knowledge Articulation

"Implicit knowledge is articulated through collective discussions, debriefing sessions, and performance evaluation processes" (Zollo and Winter, 2002:341). They argue that organizational competence improves as members of an organization becomes more aware of the overall performance implications of their actions, and is the direct consequence of a cognitive effort more or less explicitly directed at enhancing their understanding of these causal links (2002:341).

We interpret Knowledge Articulation to mean sharing experience and discussing such experience. This can take place among some of the colleagues, within a team or a shift, and between an operator and his supervisor. Antecedent to experience sharing is the cognitive process of clarifying thoughts on experience accumulated.

3. Knowledge Codification

Knowledge codification is a step beyond knowledge articulation and is represented through manuals and other process-specific tools intended to provide guidelines for the execution of future tasks. "The process through which these tools are created and consistently updated implies an effort to understand the causal links between the decisions to be made and the performance outcomes to be expected" (Zollo and Winter, 2002:342).

We interpret knowledge codification to mean the ability to write down and send the relevancy of an experience (yours or a colleague) to others. That is, that part of the knowledge which can be made explicit, stored in a computer and transferred to others (2002:340-342), in an understandably manner. Such knowledge, if enough relevant, will become a new routine. This is, however, a decision to be taken by management at the appropriate organizational level.

Dynamic capabilities

The second element in the model is dynamic capability. Incremental improvements can be accomplished by individuals through trials and errors and stay tacit. However, routine development based on deliberate change efforts through cognitive and behavioral learning processes, articulated and codified for organizational diffusion, can now be applied by geographically dispersed employees. Furthermore, by systematically allowing for externalization of experience, either through team structure, or computer-based software, this systematic way of modifying or generating new operating routines can be seen as a dynamic capability (Zollo and Winter, 2002:340).

In their learning model Zollo and Winter (2002) differentiate between *experience accumulation, knowledge articulation* and *knowledge codification*. While the first learning mechanism is regarded as behavioral in nature, the last two are regarded as "more deliberate cognitive processes" (2002:340). Zollo and Winter argues that in order for a firm to stay competitive in a dynamic market, you need (a) to improve, or develop new, operating routines and processes, (b) internal and/or external stimuli to achieve such improvements, (c) some deliberate learning mechanisms to execute the process, and (d) that such desirable change processes "are her regarded as constitutive of dynamic capabilities" (2002:341).

Dynamic capability is the result of a deliberate management policy to encourage employees to participate in the development of the organization. This capability consists of (1) a set of readily accessible value creating business and operating processes, (2) an organizational structure that encourage and process experience transfer, articulation and codification, (3) includes local and team decision-making power, and (4) made new routines available through diffusion in form of information and communication technology.

We will in the discussion chapter base our arguments on a deliberate learning theory which combines the learning mechanisms with dynamic capabilities.

Multilevel learning

Organizations can learn through multilayer structures (Crossan et al, 1999; Huber, 1991; Argyris, 1977; Cangelosi & Dill, 1965). Basing their article on the strategic view that renewal of corporation is the underlying premises for organizational learning, Crossan's et al (1999) states that organizational learning is (1) tension-based explorative and exploitative, (2)

multilevel, that (3) the "levels of organizational learning are linked through intuiting, interpreting, integrating and institutionalizing" (ibid:523), and that (4) cognition affects action and vice versa (1999:523).

Multilevel learning secures an integrated "framework for the process of organizational learning" (Crossan et al, 1999:522/4). These interacted processes are "intuiting, interpreting, integrating, and institutionalizing" (1999:525) and "related in a feed-forward and feed-backward process across (organizational) levels" (ibid:523), where the feed-forward and feed-backward is related respectively to exploration and exploitation (ibid:524). Crossan et al has theorized a logic linked to the cognitive/behavior learning theory, and can be seen in fig. 3.3.

Level	Process	Activities
Individual	Intuition	Experience/Images
	Interpreting	Language Cognitive map/Dialogue
Group	Integrating	Share understandings/Mutual adjustments Interactive systems
Organization	Institutionalizing	Routines/Diagnostic systems Rules/Procedures

Figure 3.3: Multilevel learning in organization (Crossan et al, 1999)

According to Crossan et al (1999) it is possible to achieve organizational learning through all three levels (multilevel) indicated in fig. 3.3.

> *When action takes place in concert with other members of a workgroup, the interpreting process quite naturally blends into the integrating process. Interpreting is the explaining, through words and/or actions of an insight or idea to one's self and to others. Integrating is the process of developing shared understanding among individuals and of taking coordinating actions by members of a workgroup through mutual adjustments. This process will initially be ad hook and informal, but if the coordinated action taken is recurring and significant it will be institutionalized. This is not a sequential process, but many feedback loops among the levels.*

> *Institutionalization is the process of ensuring that routinized action occurs. Tasks are defined, action specified, and organizational mechanisms are put in place to ensure that certain actions occur. Institutionalizing is the process of embedding learning that has occurred by individuals and groups into the organization, and it includes systems, structures, procedures and strategy.* (Crossan et al, 1999:525).

Seen from a strategic perspective, the authors argue that it is tension between assimilating new ideas and use of current knowledge which causes the organization to renew itself through organizational learning. While we agree in principle to the explorative-exploitative feed forward-feed backward process, we question the word "tension" (Crossan et al, 1999:530) in this relationship. Of course all such processes, removing one routine for the benefit of an other, will cause some tension both among the employees operating the old routine and those promoting new experience. However, from our perspective of renewing operating routines we have not identified such tension as relevant. On the contrary, our preliminary analysis indicates wide acceptance for both practicing current routines and sharing and using the experience from other employees when such experience have been institutionalized. We have observed, however, that within a multilevel deliberate learning structure there is a feedback loop which purifies accumulated experience to the point where it can be institutionalized. Thus, our preliminary analysis seems to agree with Crossan et al (1999) that organizational learning is multilevel, and that it is a cognitive/behavioral process leading to the development of routines. However, from our operational perspective we find no reference to tension in relation to exploitation-exploration of routines, but that the development of routines is a cooperative process between employees and levels of employees.

Seen from a development of operating routine point of view we find it necessary to focus on Crossan's et al (1999) third assumption linking multilevel organizational learning to intuition, interpretation, integration and institutionalization (1999:522). While multilevel learning is foreseen by Crossan et al (1999), where learning takes place through an explorative-exploitative feedback loop (1999:524/4), they do not identify how this process is executed, at which point in the OL process, or over which time scale, it takes place. We propose, however, that through a *deliberate* process groups at different levels learns through interpretation and integration. This follows from our observations that when one employee brings a new experience to the group, i.e. team or management, such action can also release articulation from experience accumulated by such employees' learning about this accumulated

experience. This in turn can lead to an iterative give-and-take discussion about the best way to operate a process. Such deliberate iterative processes at nested organizational levels can be done both orally and codified.

While Crossan et al is basing their observation on a strategic focus competing for funds within an explorative/exploitative framework, our research is focusing on how best to develop and institutionalize the best possible operating routine. Furthermore, although Crossan et al has pointed out that the multilevel learning process may have many feedback loops among the levels, we find no strong theoretical deduction in their article of either feedback loops or iterative exchanges of experience. Their theory builds on the fact that once a group, for example within a production unit, agree on a routine change, the new routine will be institutionalized (1999:526). This leaves out other interested parties in voicing an appropriate view. Our experience tells us that such learning may be myopic, something a nested iterative learning process may avoid.

What we are missing from Crossan et al is an organizational commitment to a deliberate, symbiotic, learning process between the hierarchical levels during the development of a routine. Rather than a strategic perspective, our concern is development of operating routines. We argue that within an operative perspective the task is to accumulate experience for the purpose of having the best of the experiences institutionalized as new operating routines. In a multilevel learning process it is management's responsibility to provide the incentives for employees to participate. We propose that two sets of learning processes are taking place at the organizational level: (1) iteration at nested multiple organizational levels before formulating and issuing new routines and (2) through institutionalization employees' willingness to apply such routines. We will return to the nested iteration concept later.

Single and double loop learning

For an organization to know more than the sum of the individual employees, the knowledge held by the individuals that is relevant to the organization's operation must over time have been articulated and codified into "structures, procedures, and memories built into the fabric of the organization" (Argyris & Schön, 1996:7). Knowledge becomes organizational by being a "holding environment for knowledge", and where the knowledge is directly represented in form of routines and practices (1996:12). Such knowledge is labeled "theories of action" and represents either "espoused theory or theory-in-use" (1996:13). While espoused theory is

developed by management, theory in use is the actual application executed by employees. Furthermore, "instrumental theory-in-use" (1996:14) contains norms for corporate performance. Accumulation of experience takes place within a *"theory-of-use"*, where the employees interpret strategy and norms, while norms are management's *"espoused theory"* of stated goals and strategy to "explain or justify a given pattern of activity" (p. 13). Together, both theories make up *"theories of action"*. We will focus on the espoused theory as this represents explicit organizational knowledge.

Single-loop learning is "instrumental learning that changes strategies of action or assumptions underlying strategies in ways that leaves values of a theory of action unchanged" (p. 20). Such learning is sufficient where "error correction can proceed by changing organizational strategies and assumptions within a constant framework of values and norms for performance", while double-loop learning is understood to mean the changes or modification of values and norms (p. 22). Only through changing the norms will the organization perform more effectively. Thus, the discovery of error that leads to a double loop will imply that (1) first the organization has to adjust values and norms that *define* effective performance, and (2) establish strategies and assumptions necessary to *achieve* effective performance. All this must then be embedded in the routines that "encode organizational theory-in-use" (p. 23).

Organizational learning occurs when individuals encounter "a problematic situation and inquire into it on the organization's behalf … that leads them to modify their understanding … and to restructure their activities in order to bring outcome and expectation into line" (p. 16). For the experience to become organizational the learning must become embedded in employees' mind or in organizational routines. This then becomes a joint responsibility of the employee experiencing the situation and the organization learning from such experience through the change of routines. In order for the organization to learn, it is important for each member to contribute, as its agent, with new knowledge incorporated into the organizational memory. That is, in order for the organization to learn there is an impetus on the organization to have its members contribute with their experience over time.

According to Argyris and Schön (1996:8), three elements need to be in place for organizations to learn:

1. devise agreed-upon procedures for making decisions in the name of the collectivity,
2. delegate to the individuals the authority to act for the collectivity, and

3. set boundaries between the collectivity and the rest of the world.

While it is the individuals who act, they act according to rules agreed upon by the collectivity. Furthermore, such rules must include a plan for delegating organizational tasks to individuals and thereby establishing organizational roles. Thus, in order for an organization to learn, a formal structure of organizational roles and rules must be in place. *"If a collectivity meets these conditions, so that its members can act for it, then it may be said to learn when its members learn for it, carrying out on its behalf a process of inquiry that results in a learning product"* (1996:11). *"In order to become organizational, the learning that results from organizational inquiry must become embedded in … the employees' mind and/or in the epistemological artifacts embedded in the organizational environment"* (1996:16). From this Argyris and Schön draw a set of lessons (1996:17). These eight steps, if leading to changes in theory-in-use and end up as embodied in the artifacts that store organizational knowledge, it constitute organizational learning. This can, of course be a single loop or double loop learning depending on whether or not the changes of routines are operational or strategic. Single and double loop learning process, according to Argyris and Schön, (1996), takes place at different levels of an organization. While single loop learning is the direct result of accumulated experience, double loop learning is the result of changing strategies.

Seen in a hierarchical perspective, double loop learning will be a rare event for an organization, often, we believe, decided by the engagement of the company's board of directors. Due to the lack of clarity of the authors' meaning of double loop learning (Espedal, 2003), we would like to incorporate in our own research the area which is left unclear: improvements or change of routines and processes which may impact on strategic change. We understand values and norms also to be within senior management's mandate for setting an organization's strategy, manifested in key performance indicators (KPI). An example of a double loop learning process is a Board of Director's instruction to management to follow government standards regarding for example pollution. Management will set those targets required to meet the standards. The targets will be in the form of a KPI performance routine. However, as operating employees start work on the routine they discover through experience that the standards can easily be improved beyond the KPI values. Once the operators communicate that they have exceeded KPI values, without added costs, management is in the position to state an improved operating strategy. For example HAL's strategy statement may read: "the company shall, whenever possible, exceed government standards on pollution". This has been a double loop learning process, instigated by employees. In other words, one

may not know in advance if an accumulated experience will lead to a single or double loop learning process.

Combining the arguments made by Argyris and Schön (1996) with Huber's (1991), we can conclude that access to routines through ICT will allow any member of the organization an opportunity to learn from this routine; that what is learned and practiced can result in new interpretations which can be shared with colleagues through the use of computer; and that through some process, experience may result in an improved routine. However, some times bad ideas are brought into the process, and if enacted upon may be costly for the firm. Thus, we need to infuse into the formal structure a method of vetting all experiences before they become institutionalized as formal routines. We need organizational roles handling deliberate, multilevel, and iterative routine development.

While Argyris and Schön (1996) points to the necessity to establish organizational roles, for the purpose of making decisions based on experience feedback, we are missing how such experience is converted to new routines. Also the description of how single/double loop learning takes place lacks the details of how and where such routines are being changed. Thus, the knowledge of how routines, single and double, are developed and institutionalized seems to be missing in this theory.

Organizational memory

While some knowledge remains tacit other can be externalized. We will in this study focus on knowledge that can be externalized and transferred as information to the users in form of operating routines. While we know that humans have memory (Walsh, 1996) organizations have it also (Huber, 1991). Being able to store knowledge in form of representation of individual knowledge articulated and encoded into routines and other artifacts, it is possible to diffuse and implement routines by the operating employees. What we are particularly concerned with is the transfer of accumulated experience, converted to codified knowledge through a deliberate learning process, with the resulting new operating routines to be replicated across a large and dispersed organizational population. Phantom the argument that such experience-based knowledge can only bee transferred through a master-apprentice relationship (Cook & Yanow, 1993), or in a community of practice (Brown & Duguid, 1991), where such transfers relies on storytelling. One of the important aspects of being able to learn through computer-supported knowledge representation is that "organizations frequently do

not know what they know" (Huber, 1991:106), as was pointed out in chapter one. In a dispersed organization it is virtually impossible to rely on personal contacts for transfer of experience-based knowledge. "The potential for reducing this problem by including computers as part of the organization's memory is considerable, and deserves investigation by organizational scientists" (1991:106).

According to Easterby-Smith and Lyles (2003), knowledge management (KM) research is primarily concerned with the practical application of computers in managing organizational knowledge. We have not seen relevant literature arguing that computer systems can support organizational learning. However, our preliminary analysis indicates a difference in the reaction pattern among employees in relation to the old and new compute system. Hence, some ICT systems may be more supportive to OL than others, possible due to KM system structure. According to Scarbrough and Swan (2003), however, there is little evidence as to which KMS that support organizational learning. Yet, we know KMS is being used for the purpose of supporting OL, and that ICT is recognized as a tool for replicating organizational knowledge (Huber, 1991). However, Huber argues that the effectiveness of organizational memory is depending on three elements: information acquisition, distribution and interpretation (1991: 106). The first point relates to attention to what is stored in the memory, while the second point relates to criteria for using stored information. The third point relates to individual employees' "cognitive maps or frames of reference, which are indefinable except in terms of a memory. Thus the basic processes that contribute to the occurrence, breadth, and depth of organizational learning depend on organizational memory" (1991:107). From this we will argue that there are differences between ICT/KM systems. Thus, we will in chapter 6 include some of the basic issues related to KMS – presentation of knowledge representation, in order to find possible explanation for this observation.

Summarizing the above learning elements we have not been able to identify within these theories how, when and under which circumstances routines are being developed and institutionalized. Nor do we know enough about why some ICT systems seem more supportive of organizational learning than others. Through our preliminary analysis we found some additional issues which may explain some of our findings. These issues are nested iteration, empowerment and system innovation. We will discuss these below.

Nested iterative learning

Nestedness seems to be applicable to a range of meanings, yet we have not been able to identify a universal definition. Nestedness, according to Bascompte & Jordano, is a concept borrowed from island biogeography to illustrate how a pool of animals is redistributed among a set of islands living in a *symbiotic existence* between animal and vegetation (2006). One can use an analogy and imagine that an organization is an "island" that harbors several groups of employees which are supported by it and which supports its existence, in a mutually dependent relationship between the groups. Such a mutually dependent matrix is nested if groups of employees interact with proper subsets of the set of employee groups of employees interact with. That is, groups of employees within an organizational Sector interact with employees in the operating sub-set units within that Sector in an iterative process where the groups feed on each others' knowledge, much like plants and animals feed on each other for mutual benefits (Bascompte & Jordano, 2006). Such nested iteration can be both vertical and horizontal in nature. Rose (1998) points out that a complex system is essentially nested organizations having behaviors which are reversely and inversely connected, and thus able to feed on each others' knowledge.

In organizational science the organizational level is a nested system (March, 1991), where learning takes place at several nested levels (Levitt and March, 1988). In such multilevel learning, organizations learn simultaneously both to discriminate among routines and to refine the routines by learning within them (Levitt and March, 1988:78). This occurs at individual, group, and organizational levels. The collective learning of the individuals is combined via hierarchical structures into the collective action and learning of the organization (ibid). A nested learning community, according to Resnick and Hall (1998), is an organization where learning is a key part in the pursuit of continuous improvement on the part of everyone in the system.

What we are missing in Levitt and March's (1988) nested learning is a mutual dependent iterative dialogue within a multilevel organizational structure, where employees learn at the levels of individual, group and organization. We will argue that

> *nestedness relates to the institutionalization of developing routines, linking multiple organizational levels in a symbiotic process of mutual dependence for the purpose of organizational learning, taking place through an iterative process between nested groups of employees working toward a common goal of improving productivity*.

Empowerment

Another issue that came up through our preliminary analysis was empowerment. We can describe *empowerment* as involving employees in a change processes by giving them power and means to alter own processes and routines. Empowerment is not a new phenomenon in Norwegian culture. Thorsrud and Emery (1969) are reporting of a tradition of "widely applied empowerment (selvbestemmelsesrett) with deep roots in the Norwegian society" (1969:9). Their findings suggest that:

> *The more each employee is capable of exercise control over own tasks and to see his/her activities in a relationship to colleagues, the more likely s/he will be to have a positive attitude. This positive attitude will be materialized in different ways, not least through releasing personal initiative and creativity" (Thorsrud & Emery. 1969:13)*

The dialogue Thorsrud and Emery refers to is between so-called partly self-managed teams and management. Here management base their decision-making process on a socio-technical theory by replacing their primary tasks from internal control over each unit to control of relationship between units and tasks, leading to focus on tasks rather than persons, and places responsibility where it is most effective (1969:180-184).

According to Kirkman and Rosen (1999) team empowerment consists of four dimensions:

- Potency: team competencies to execute performance related to own work processes
- Meaningfulness: team experience tasks as important
- Autonomy: members experience a collective freedom to execute team decisions
- Impact: execute work that is significant and important for the organization, by seek out, share, and collectively understand feedback from other organization members.

Our preliminary analysis found that HAL's management had invested in a strategy of Value-Based Management. On that basis they implemented empowerment in the organization. According to Adler (1993) what makes empowerment "so enormously effective (is due to) its ability to make production problems immediately visible and to mobilize the power of teamwork. Implemented with trust and respect both these features of the system create real empowerment" (1993:107). Thus, empowerment is the sharing of decision-making power between management and employees in a "consensus-based decision-making drawing higher and lower (organizational) layers into a dialogue" (1993:107). In view of ability for

organizations to learn, empowerment is a natural consequence of a strategy for routine development. This is particular true with larger organization where "formalized and complex structures retard learning but that learning is enhanced by structures that diffuse decision influence" (Meyer, 1982:533). According to Grant (1996) is "the renovation of traditional organizational structures through delayering and empowerment (a result of) the knowledge-based approach (which) offers a theoretical basis for understanding a number of recent organizational innovations and trends" (1996:120). Spender (1996) clarifies this further:

> *"The theory of bureaucracy presupposes that all the knowledge necessary to the strategizing and organizational design processes is available at the top of the organization and this underpins its authority base. Whenever this is not true and lower-level employees are able to deal with uncertainties which cannot be resolved by senior management, they have power over the top management"* (1996:46).

As learning increases employees want to have greater "independence and autonomy" (Cangelosi and Dill, 1965:192) due to "a necessary relationship between the learning and the employee's active involvement … (who) learn different things about the process of transforming inputs into outputs" (Spender, 1996:46). Thus, the above demonstrates a link between the strategy to implement deliberate organizational learning and empowerment. However, one thing is that management say it has implemented empowerment another thing is if the organization recognize it as real. In the second interview series (1995) we raised this issue with the informants.

We will in this research empirically analyze operating units when they are changing ICT systems. This will be done in order to detect differences in its use, and if/how they use the system for routine development. Employees empowered to engage in the development of the firm is more likely to participate than those not given such trust (Thorsrud & Emery, 1969). In order for employees to participate in routine development, therefore, they must be empowered to do so, be willing to share experience, and, if computer is to be used, able and willing to use it by sending experience proposals and apply new routines. Finally, computer facilities must be available to the users for them to apply BPS. The consequence of fulfilling this is that the measurement variable – development of routines - will naturally change as employees are proposing changes to current routines. What may influence routine development further is management's ability to provide a deliberate system for developing routines. Thus, if empowerment was in place under both technology systems we should see employees using

both systems for routine development. From Thorsrud and Emery we know that Hydro introduced as early as 1969 some form of empowerment in its organization (1969:154). Thus, empowerment was present under both SDOCS and BPS regimes.

Knowledge Management

Knowledge management research is primarily concerned with the practical application of computers in managing organizational knowledge (Easterby-Smith and Lyles 2003). We have not seen relevant literature arguing that computer systems can support organizational learning. According to Scarborough and Swan (2003), furthermore, there is little evidence as to which KMS that support organizational learning. Yet, we know KMS is being used for the purpose of supporting OL, and that ICT is recognized as a tool for replicating organizational knowledge (Huber, 1991). Thus we will argue that more theory must be built into this concept in order for it to have explanatory power. According to Easterby-Smith & Lyles KM is a concept based on "the neo-economic view of the strategic value of organizational knowledge" (2003:12). This puts KM in the category of cognitive science where one can argue that the ability to interpret information presented through a computer media can be related to cognition.

The theory of media richness (Daft & Lengel, 1986) has learned us that what is displayed as information must be both clear "so that tasks are performed under a reduced level of uncertainty" (ibid, 1986:556), and unambiguous so that for each routine to be executed an operator does not have to figure out his/her own interpretation of its meaning (ibid, 1986). Furthermore, according to systemic innovation theory (Grønhaug & Kolltveit, 2005) there is a difference in behavior between those participating in developing a system and those who do not participate. Systemic innovation theorizes that those who participate in the design of a KM system, regardless of the contribution, are more willing to use such systems than those who have not participated in its design (ibid, 2005:58). Furthermore, those understanding the properties and functionalities of technology "will use the technology with the intention of improving or enhancing their existing work processes" (Orlikowski, 2000:423). We interpret Orlikowski to mean that employees participating in a system's design will most likely also understand the property and functionality of the system, supporting the theory of systemic innovation.

Vera and Crossan have proposed "the co-alignment between a firm's learning - knowledge strategy as a moderator of the impact of learning and knowledge on performance" (2003:137). One can therefore argue that by linking KM to OL process such "combinative capability" (Almeida et al, 2003:366) may lead to useful development of routines for the purpose of enhancing performance. To achieve such goal, however, the computer system targeted as a mean to enhance routine development need to be used by the employees. Therefore, w*e will add to the KM literature by pointing out the need for such media to also be measured through its richness and users' design participation.* Thus, KM theory, incorporating these elements, may shed some light on which circumstances employees may be in for them to use a knowledge management system.

3.3 Tentative research model

The influence of ICT-based systems on routine development and value creation will be analyzed applying primary and secondary data gathered within HAL. It will be done in relation to its implementation of ICT-based system in at least two of very similar production sites, Karmøy and Høyanger. Furthermore, Karmøy represents two business units we tested, with MP-MS being downstream of PM in the company's business process. This gives us the possibility to compare two differently geographic and functional units with partly overlapping, partly complementary characteristics that will allow us to detect and validate explanatory patterns in the data (Yin, 1994).

Figure 3.4 presents the tentative research model of our project:

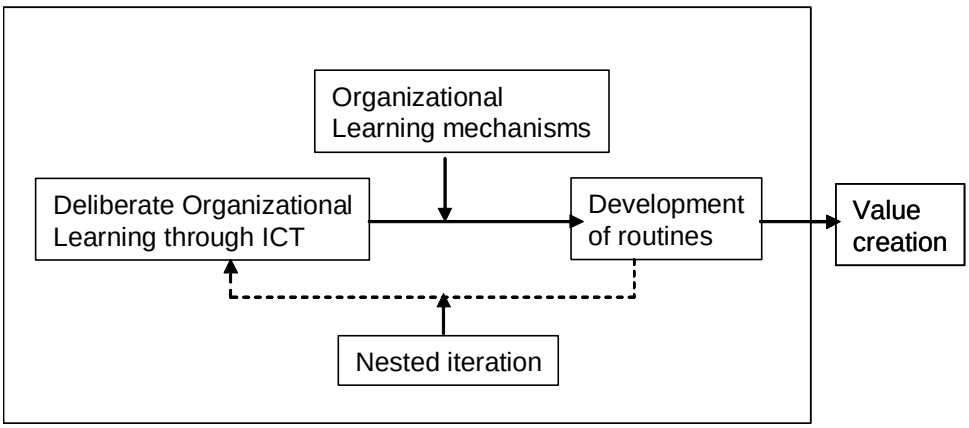


Figure 3.4: A theoretical perspective on routine development

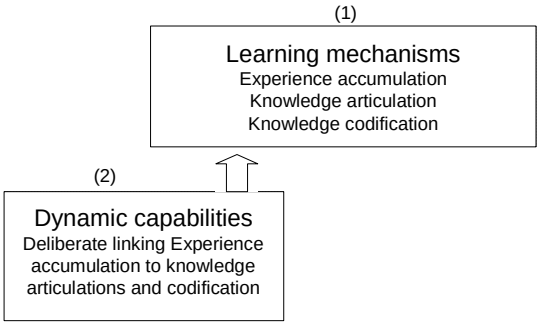
The independent variable is an ICT-based system for knowledge elicitation and representation. The dependent variable is routine development while organizational learning mechanism is the moderating variable. The end result of routine development is improved value creation. The whole arrow line in fig. 3.4 indicates that the ICT system is expected to have influence on the users to stimulate routine development, while the stippled line indicates accumulated experience being feed back into the system through nested iteration. Once the new experience is incorporated into the system it will have a positive effect on value creation. Our preliminary proposition is that the organizational learning mechanism is a moderating variable necessary for routine development to take place, and that both learning and development takes place in the organization when the environment for improvement is made deliberately. We anticipate that such environment includes an organizational openness to access relevant data and feed back experience through a deliberately planned system for organizational learning and routine development, establishing dynamic capabilities.

3.3.1 Nested deliberate learning theory

We will in this section discuss the implementation of nested iteration into the deliberate and multilayer learning theories. From the above we have seen that organizations can learn at multiple levels (Crossan et al, 1999; Levitt & March, 1988, Cangelosi & Dill, 1965). Furthermore, Zollo & Winter argues that for each level of the learning mechanism the cost to the organization is increasing, with the level of codification being the highest (2002:345). In analyzing the cost aspect, they argue that the most important cost element at the level of codification is task features, synonymous to operating routines (ibid:346). The cost of providing a deliberate learning process to an operating routine depends on the routine's importance in the value creation, that is, the role of the routine is dictating the economic costs of not doing it right. For example, an important task the organization is trying to master will clearly justify a relative higher level of investments in a deliberate learning process then would a task of insignificant value. Thus, while Zollo and Winter tries to analyze what operating routines warrant a deliberate learning investment, by analyzing the moderating role of task features (2002:346), they have taken for granted that by introducing a deliberate learning process, accumulated experience will flow through the system with perhaps a new routine as an outcome.

We will build on their deliberate learning and dynamic capability theory (fig. 3.5) while at the same time be looking at the situation from a different deliberate learning perspective. Firstly we will apply the cognitive/behavioral perspective rather than the evolutionary. Secondly our departure point is that HAL's management has decided to implement a complete deliberate organizational learning system, including structural changes made to the organization. Thus, rather than arguing what may or may not be economical for the firm to implement, HAL's management took the decision that the system should be available to the entire organization, that the organizational and structural elements had to be in place, and that the cost of developing new sets of routines, once in place, was sunk. However, it is not enough for senior management just to order the implementation of a deliberate organizational learning system. Our question is related to if, how and under which circumstances it can work.

We are basing our deliberate learning theory on the three learning mechanisms: experience accumulation, knowledge articulation, and knowledge codification. But rather than trying to hypothesize its costs, our case builds on the fact that the system is in place, the organization is restructured and the issue now is what it takes to work. Furthermore, we argue that in order for it to work some mechanisms has to be in place beyond what Zollo and Winter (2002) has proposed. We propose that the hierarchical levels need to be nested for the purpose of organizational learning, and that such nestedness is supported by an iterative process between groups of employees, both horizontal and vertically, working toward improving productivity. Such organizational structure, we believe, must be in place for a deliberate learning concept to work. A deliberate learning process supports two sets of activities: the learning mechanism and nested organizational learning. The deliberate process consists of a routinized way of converting experience into articulated and codified language for infusion into an existing, or developing a new, routine. This process can also include a computer system supporting such routinization. The learning mechanism, without a deliberate learning structure, results only in an incremental adjustment to local operating processes (Zollo & Winter, 2002:341).



Based on and modified Zollo and Winter, 2002.

Figure 3.5. Deliberate organizational learning.

Nested iteration within a multilayer structure

While the learning mechanism is seen as moving horizontally, the learning process is also moving vertically through an iterative process within a nested organizational structure. In order to avoid myopic learning the multilayer learning process must be nested, iterative, and institutionalized. Only through a deliberate development process owners will be able to make decisions on insight matched against experience by interested groups of employees.

The iterative process leading to a new management-approved routine consists of three levels of organizational learning: Individual, Team/Group and Organization (HAL), each level with its set of processes and activities. At each level, we believe, the learning mechanism can take place. How elaborate the deliberate learning process will be at each level of the organization depends on the nature of the experience and how important it will be for the organization to develop a new routine. An accumulated experience, if significant for the organization, is followed by an institutionalization (Crossan et al, 1999) and a diffusion/implementation processes supported by ICT. It is this process which again is contributing new (raw) information that can provide the diversity needed (Huber, 1991) to start a new experience-based learning cycle.

According to Crossan et al (1999) organizations learn through a dynamic process of “tension between assimilating new learning (feed forward) and exploiting or using what already has

been learned (feedback)" (1999:532). We will modify Crossan et al's (1999) structure (1999:525) in relation to our preliminary observations. On the individual level we have observed that there are two types of experience sharing: Through team, or through management. 'Group' equals 'team' in our research, while 'organization' in Crossan et al is in our case a two-phased process in relation to learning. Management represents the organization and interprets the proposal from a team before they approves and institutionalizes the new routine on behalf of the organization. Team sharing means normally an oral iteration, while management sharing normally means computer-supported iteration. A team can have accumulated experience disputing an articulated claim made by an individual member. Once the individual and team have discussed and found a common ground for a new routine, the experience will either be written down before encoded to a computer, or encoded directly into a computer, before transferring to management. At the organizational level management will receive this proposal, who will engage in a computer-based dialogue for interpretation before converting the proposal to a new routine (institutionalization). Rather than a tension scenario, we maintain a cooperative scenario in relation to changing current operating routines. On this basis we want to adjust Crossan et al's (1999) multilevel learning table (see fig. 3.3) by including a nested structure allowing for an iterative process. The adjustment can be seen in fig. 3.6: Multilevel learning through nested iteration.

Level	Process	Activities
Individuals	Experience accumulation	Experience
	Knowledge articulation ↑ Knowledge codification	Language
Individuals Group	↓ Knowledge articulation ↑ Knowledge codification	Share understanding Mutual adjustment
Individual/Group Organization	↓ Knowledge articulation Knowledge codification Institutionalization	Routines Rules & Procedures

↔ Nested iteration. Based on and modified Crossan, et al , 1999.

Figure 3.6. Organizational learning through multilevel nested iteration

Our preliminary findings suggest that an individual communicates through both articulation and codification, applying oral and written approaches, to both team/group and management for the purpose of having his/her accumulated experience institutionalized. This way development of routines becomes nested and iterative through an employee-management cooperation rather than tension.

Two ways of transfer information: (1) Diffusing new routines out into the organization for implementation – feed forward and (2) feed back experience informing the organization about ones discoveries. Diffusion is the act of management distributing new, institutionalized, routine for implementation in the organization. Experience feedback is the act of sharing accumulated experience with team/management. However, an organization will not allow raw experience to be diffused directly to its members without first being reviewed by management. If experience is sent directly into the information channel of the organization such feedback may result in myopic or superstitious learning (Levitt & March, 1988), and will most likely not be accepted by the employees as it is not institutionalized. Thus, such experience is handled in two ways: sharing with team before sharing with management (indirect contribution), or sharing with management directly (direct contribution). This way there is a control on how new routines are being structured and distributed. Organizations learn as a result of articulation and codification of knowledge derived from reflection upon past experience (Zollo & Winter, 2002).

Whenever activation of the learning mechanisms within the single/double loop learning theory (Argyris & Schön, 1996) lead to modification/change of routines at the organizational level routine development has been taking place (single loop learning). Furthermore, if activation of such mechanisms leads to changes in Key Performance Indicators, and hence changes to strategic goals, then routine development at the double loop learning level has taken place. Both levels of routine developments can be said to result from the firm's dynamic capabilities. Furthermore, if such development was supported by ICT then we will argue it is ICT-supported routine development. From the above, computers seem to be able to support both feed forward and feed backward in developing operating routines at all levels of the organization. We call this nested organizational learning.

In order for a new routine to be retained within the organization, each employee must interpret the new information. Our preliminary findings indicate that based on the individual

knowledge structure accumulated within an industrial context, such interpretation should be relative uniform. If a new routine is being successfully implemented in the organization we call this organizational learning. Furthermore, if the routine is being learned through the support of ICT, then we will argue it is ICT-supported organizational leaning.

3.4 Summary

The aim of this thesis is to point to relevant issues regarding the organizations ability to develop routines through the support of ICT tools.

As a departure point, a tentative research model was presented. The focus in this model is routine development supported by ICT. This is a dynamic model as each routine, when made available to more employees; more of the organization will learn and propose new improvements, allowing for more organizational learning (Huber, 1991). However, the case may be that there is no mechanism, in any form, either technical or organizational, for employees to participate in routine development through sharing of experience. Then, in principle, no proposals should be forthcoming from employees, resulting in little or no application of useful new routines based on employee experience. Thus, whenever employee proposals for improving/changing operating routines are forthcoming, some explanatory factors should be present. Furthermore, not all explanatory factors are the same in all aspects of routine development processes, but where they are present they can explain phenomena in different phases of the development process.

In this chapter we have identified the literature on which we will base our thesis, which theories we will draw on, and have described a tentative proposition. In the description of the routine development process in Hydro Aluminium and analysis of the empirical findings, we will draw on the theory on deliberate organizational learning and multilevel learning in order to find explanations related to if, how and under which circumstances ICT can support routine development in the organization. While our research focuses on their ability to participate in routine development through the application of the 2003 installed BPS, and thus replacing the old SDOCS, we need to first secure an understanding of how organizational leaning takes place within the teams/groups and organization. By identifying deliberate organizational and multilevel learning as the basis for our research it is natural to focus on the cognitive/behavioral theories. Organizational learning is antecedent to development of routines, which again is based on action, reflection, modification/change, and

institutionalization. In order for an organization to develop routines based on the cognitive/behavioral processes, organizations must be able to learn through the application of artifacts in form of a nested and iterative multilevel process. Thus, an ICT -supported routine development process, means an organization's ability to apply computers to diffuse institutionalized routines out to the organization for learning, and for employees to feed accumulated experience back into the deliberate, nested iterative multilevel learning process.

Furthermore, we have also applied single-loop/double-loop learning and find the theory valuable in view of the two levels of learning which we have seen from the preliminary analysis. Finally we have applied theory on organizational knowledge; where operating routines can be stored for diffusion throughout a dispersed organization. On this basis we have formulated a tentative research model (fig. 3.4).

We will in chapter four present the methodology used, where we will discuss the research design, data collection and analysis applied and issues of validity and reliability. In chapter five we will report findings and analysis before we in chapter six discuss the findings. Chapter seven concludes this research with implications and further studies.

4 Method

This chapter reports the methodology underlying the empirical part of our study. Research comprises a variety of important tasks and approaches leading to some theory building or theory support. Our approach is a set of iterating activities within a research process consisting of choice of research topic, research problem, methodology, data collection, analysis, findings and discussion (Ghauri & Grønhaug, 2002). This chapter is organized as follows: First a discussion on the choice of research design, followed by the research setting, data collection, data analysis, and validity and reliability before a summary is made. The research design is the result of the requirements, which are given by the nature of the research question in the thesis. Through the choice of research design - a longitudinal case study - we will describe how we conducted data collection and the analysis. Data collection methods include different sources of data and details about how the data were collected. In the section on data analysis we will present different steps taken in the process. We will conclude with a discussion on validity and reliability before summarizing.

4.1 Research design

Our chosen topic is development of routines within large organizations. Below is set out the research methodology we would like to pursue. Our objective is to contribute to the scientific community through exploring, in an empirical setting, how computer-supported knowledge representation may enhance routine development in an organizational context. In particular, if such computer-supported knowledge representation can support organizational learning for the purpose of developing routines, we would like to explore how and when. To gain insight into these questions there are certain requirements that the research design must fulfill.

4.1.1 Criteria for design

A research design can be described as a logical structure that establishes a link between the original research question(s), the collection of data and conclusions that can be drawn (Ghauri & Grønhaug, 2002). In chapter one we outlined the research question and in chapter three we presented a tentative perspective. Business organizations today apply computer systems for developing, sending and retrieving information. This thesis will study computer-supported routine development. Here we define development of routines in organizational terms, that is, how an organization is able to improve/develop new routines. Routine development is not a

new issue. What is of interest here is if computer-supported knowledge representation does enhance development of routines, how is it achieved, and under which circumstances. Because such development does not occur in isolation, but rather in context, the aim of the analysis is to capture the routine development as it occurs in an organizational setting. Is routine development enhanced by the change of computer system regimes, or are there other aspects influencing such development? Answers to such questions will give the researcher information and understanding of the organization's routine development process. In order to get insight into the research question this study requires: (a) access to an organization replacing one system with an other, (b) access to organizational units being exposed to change of system before and after such replacement, (c) access to the implementation process and evaluation report of own success, (d) access to management's goals of the replacement process, (e) access to how and under which circumstances routines are being developed within the organization.

Earlier we have described routine development as an important objective for the value creation of a firm, and that such development depend on organizational learning. We have pointed out that such organizational learning, using computer-based knowledge representation, is poorly dealt with in the literature. In addressing such a question access to a research setting is fundamental. Organizational learning and routine development processed have to be studied in its natural setting in order to understand and detect factors that will determine or influence how and under what circumstances organizations develop routines when the basis for such knowledge is being represented through a computer. But access to only the organization, or the project organization, would not satisfy research requirement. Organizational learning and routine development has to be studied in its natural settings in order to understand and detect factors that will determine or influence how the organization develops new routines. Thus, in addition to gaining access to the project group developing the BPS, we needed to gain access to operating units being exposed to changing computer systems. On our behalf, the project manager negotiated with operating units to find some units that were willing to being interviewed. We were able to secure two operational units located at different places, studying routine development in a natural setting.

During the development process, the project organization monitored their progress by asking employees how they valued the new concept. Our study does not consider the implementation of the study as such, that is, we are not monitoring change. Our focus is on routine

development. However, being able to access such information as how the organization evaluates the development and implementation process will reduce the number of variables the routine development process can be influenced by. We not only obtained the plans of the project, but also the results of the employees' view of the process. By being informed of the process in real time one is able to capture what influence the actual process of evaluation. Our data collection includes targeted interviews, video tapes, observations and documents.

A further requirement was the goal of the organization. The implementation of a new computer system regime must be a strategic decision, or the employees will not take it seriously. That is, a routine must be institutionalized for employees to apply it. But not only must it be a strategic decision, it must also be viewed by management as important for the future of the company and its earnings potential. Thus, we needed to get access to management. Management must have an incentive for implementing new management processes. Parallel with the change of data system they altered the organization structure from geographic units to operating sectors, while reducing management levels, making the organization flatter. We needed to collect management goals for the implementation of BPS in order to understand which influence management *goals and strategy* had on employees' application of the new computer system. Such access was given, and we were able to interview management at three of the organization's five levels.

Exploring which factors influence computer-supported routine development can either be done through collecting real-time data or through getting retrospective information. Gathering information for this research project is best conducted through collecting real-time data. This will give insight into reasons why certain routines are followed as the actual process of routine development is taking place. Real-time data is preferable to retrospective data in order to reduce the risk of failing or skewing memory. *Real-time* data will thus include data on the actual routines, the conditions under which these routines are followed, and the context that influenced the way the organization developed such knowledge. Through the analysis of real-time data, one will get information on how certain routines were preferred when the organization wanted to develop and share knowledge.

Access to the organization at different time intervals is required in order to evaluate the organization's participation in learning and developing new routines under different computer system regimes. In order to capture the pattern of applying the computer system for learning

and routine development over time, before and after the implementation of BPS, longitudinal data can be collected which allows the present state to be explored in relation to the past and the future. Choosing one time period to study routine development would not be sufficient as one would not capture how the two systems individually supported such development, nor how the employees are applying the two systems for the purpose of participating in the routine development process. Routine development may be identified either through a time-series design or a longitudinal study. However, an in-depth understanding of how and why such development occurs, which incorporate possible variations in reasons over time, requires a longitudinal study. Furthermore, only by collecting data continuously over a longer time period is it possible to ensure that the reason for routine development are included in the data set. Therefore, in order to capture routine development over time our agreement with the organization ensures us access to data over a *long time-period*.

The major requirements to the research question of this thesis have now been discussed. These requirements give further guidelines as to what research design is the most appropriate for this study. The objective of this study is to gain understanding and explore if and how routines are being enhanced through the application of computer-supported knowledge representation and if so which factors influence this process. These research questions are interesting to study, as there is limited a-priori knowledge on the phenomenon in this thesis. In order to get answers to these questions we will study the phenomenon under study real-time in its natural setting over time.

4.1.2 Choice of design

It is important that the thesis' research problem, research theme and purpose become the guideline for which method is applied. It has been argued above that the phenomenon of interest requires detailed and in-depth information. Our research problem focuses on social processes rather than social structures. An explorative and intuitive research design will be advantageously applied. The skills and experience of the researcher play an important role in the analysis of data (Ghauri & Grønhaug, 2002). We are primarily occupied with describing, analyzing and explaining the "***how***" and "***why***" of some ***circumstances*** leading to new routines. A qualitative study is therefore found most suitable (Yin, 1994). The objective of our thesis is to explore if, how and why represented knowledge may lead to new routines being developed, and if replacing one computer system with another will have an impact on such development.

We need to incorporate in an explorative research some flexibility. It is difficult to know in advance how the object of our research is functioning, what is the context, structure and operation of the case. We need to find out what is inside peoples head. Thus, Critical Success Factor Method (Fuglseth, 1990) will support our aim in understanding what steer management in the direction they are going in, and what concerns they have.

An ***explorative*** study can be applied when the theoretical basis is weak, while an explanatory study tries to explain the causal links in a real-life setting too complex for the survey or experimental method to handle (Yin, 1994). While our research area has been conceptually discussed, we do not have a valid theory, or enough empirical data to formulate such theory. Thus, our research problem is not fully understood. We believe that an explorative design serves our purpose better than a descriptive and causal design, particularly as the problem can poorly be confined, and the researcher has unclear or incomplete understanding of what is the central dimensions and variables and the relationship between them (Grønhaug, 1985). We do not have a strong theoretical foundation for our question, and little control over contemporary, behavioral, events. An explorative study is thus the most appropriate for answering the research question of interest, and where causal links are being investigated. In view of the scarcity of a-priori knowledge in existing literature related to the research question, we will choose a research design that gives detailed and in-depth information, such as through explorative studies.

A research strategy depends on three conditions: (a) the type of research question, (b) the control an investigator has over actual behavioral events and (c) the focus on contemporary as opposed to historical phenomenon (Yin, 1994, p. 1). Thus, choosing a research strategy is an important step when selecting a research design. Our research question is related to the issue of organizational and managerial processes in a contemporary setting where the boundaries between phenomena and context are not clearly evidence, and where current theory is inconclusive. As there is limited research on computer-supported routine development where one is focused on how organizations actually achieve such results, this study will explore the process as it evolves. This implies to gather real-time data over a long time period, and incorporate contextual factors that may influence the process. According to Yin (1994), under such circumstances the appropriate strategy should be a case study. Yin defines a case study to: “investigate contemporary phenomena within its real life context, especially when the

boundaries between phenomena and context are not clearly evident" (Yin, 1994, p. 14). Case studies can be useful when "how" and "why" questions are being posed; the focus is on a contemporary phenomenon with real-life context; the process in question is not yet thoroughly researched; and the history of past or current phenomenon is needed (Yin, 1994; Leonard-Barton, 1990; Eisenhardt, 1989).

Finally the objective of this study is to incorporate existing knowledge on our chosen phenomenon with the findings of this study, which may bring research on this phenomenon further. However, as there is little a-priori research on the specific phenomenon of interest in this thesis, a longitudinal case study is therefore the preferred research approach here.

4.2 Data and data collection

Multiple sources of data are a requirement for case studies and these studies typically combine data collection methods such as archives, interviews, questionnaires, and observation (Eisenhardt, 1989). The purpose of multiple data collection is to secure triangulation - providing stronger substantiation of constructs and propositions (Ghauri & Grønhaug, 2002; Eisenhardt, 1989; Jick, 1979). In this study the aim is to collect data that will enable us to answer the research question. In order to get an answer to the issue of routine development we need to (a) ensure a close relationship with the organization being studied, (b) use both primary and secondary data in the study, (c) use longitudinal data, and (d) use real-time data where information is collected as the actual implementation is taking place. The sources of data in this thesis were collected through the following means:

- Interviews
- Observations
- Participation
- Archives

Interviewees	Interviews	Observations	Documents	Audio-visual
1 Management				
1.1 Senior	X		X	X
1.2 Middle	X	X	X	X
2 Employees				
2.1 Operating	X	X		X
2.2 Staff/expert	X	X		X

Table 4.1. Information source

All interviews were audio taped. In addition to making notes, unclear transcriptions were reported back to the informants for clarification. Taping of the interview was clarified with senior management, project manager and the person being interviewed. Taping the interview allows me to take notes and do follow-up questions, or deviating from the questionnaire, whenever that was required. This opened for more extensive exploration for open-ended interviews. Having a long experience in developing and implementing business systems gave me an insight into the activities of the informants, a domain I understand, and thus served as a basis for understanding the results as the interpretation and analysis of the data collected is being carried out. Furthermore, such own experience gave me the possibility to clarify unclear answers given during interviews. This way the basic understanding of collected data will, I believe, make for a more sound analysis.

I was asked by the project manager to participate in some meetings in relation to the development of BPS. Members of the development team were dedicated and knew what they wanted with the system. Once into the meeting's business they forgot that I was present. Although the development team was not the aim of my inquiry, such meetings gave me hands on experience on how the organization planned to conduct the implementation, and which conflicting elements they had to overcome in order to obtain a successful implementation. It also gave me an indication on how the results would be used once implemented in the many production units. However, the negative effect of such participation is the chance of becoming

too involved by “going native”. This could disrupt the analysis of the data. The threat of becoming too involved in the process was something I discussed with the project manager, who accepted that my role should primarily be observational. Being aware of this issue helped us to maintain an objective view of the analysis. Below is a discussion of the different sources and how the data was collected.

4.2.1 Primary data

The primary data in this research is from interviews with key informants representing different levels in the organization. At management level we used Critical Success Factor method (CSF) (Fuglseth, 1990), applying a structured interview guide. At the operating level we used semi-structured, Critical Incidents Technique (CIT) interviews (Flanagan, 1954). All interviews were audio taped, and some interviews related to operators where also video taped.

Management group: CSF interviews

We started the collection of data by interviewing management for the purpose of establishing a context specific framework for the goals of implementing BPS. Then we interviewed employees at both Karmøy and Høyanger. The CSF interview is a structured interview eliciting the participants’ goals and the factors they believe are critical to attain the goals (Fuglseth, 1990). The interview is, therefore, helpful in transferring the organizational goals, policies and directions into a context specific standard for understanding the success expected from the implementation of the computer-based business system. The participants in the CSF interviews were a group of five managers, ranging from Sector President, Primary Metals and Vice President, Metal Products, to plant managers for Høyanger and Karmøy, and the Project Manager for BPS. The purpose of the interviews was to elicit goals and critical variables from the organizational point of view, and relate such goals to the implementation of BPS.

The data for each participant was categorized and fed back to each individual in order to have the analysis validated. In this process the data was also summarized, making it easier to detect consistencies/inconsistencies in the perceptions of goals and critical factors among the participants. In addition to serve as a context specific standard for understanding the anticipated success, we used the critical factors in the construction of the case interviews. The tape from one of the production managers was difficult to decipher, partly due to low battery capacity. Those questions we did not get answered was written down before we called the manager asking him if we could take the missing questions on the telephone. This he refused.

Thus, in the analysis we will only compare the answerers given by this manager with the answers given by his colleague manager.

Operating groups: Semi-structured CIT interviews

The basic structure of the case interviews was the CIT. We developed the questionnaires for the operating employees based on CIT while being cognizant of the goals and intentions of the management. The goals and success factors of management were used in the formulation of the semi-structured questions. The participants in the case interview were operators at the two production units Karmøy and Høyanger, and represented employees from both PM and MP, as well as production employees and staff/functional employees. This study started out with the intention to measure a series of activities by the employees in their application of the old and new computer system, as well as between new and old employees. In order to achieve such detailed data for analysis, we needed access to different types of employees, working in different location, applying both old and new system. It turned out that none of this was possible to achieve. Some managers in the operating environment did not feel it worth while to do such a study. In addition, the whole implementation process in the PM Sector was delayed by more than a year. Thus, rather then doing a quasi-experiment, we ended up doing an explorative case study. We were given access to four employees at the two sites. They were all experienced in both operational and functional activities. Some of them had participated in the development of the BPS, and some of them allowed us to videotape when they demonstrated BPS. Such videos can illuminate the ease of access and utilization of the new system.

The actual case interviews had the form of a semi-structured conversation. We asked some focused questions while the informants were allowed to answer freely. Sometimes the answers triggered un-planned questions. The interviews were carried out in the period prior to and after the implementation of BPS. The main focus in the collection of primary data from the operating level was to get insight into whether or not computer-supported knowledge representation did lead to new knowledge being developed. Management data was used to see if what they thought would happen in fact did happen. However, the first set of interviews did not give an answer to all of the issues relevant to the research question. Thus, in addition to repeating some of the questions from the first interview, to see if in fact employees had same views, questions related to organizational learning was added in the second interviews. The

interviews took on average 75 minutes. An exemplar of the interview guide for first and second interviews is enclosed as Appendix C.

Observation and participation

This was done in form of participating in meetings and work shops related to the project team being responsible for developing BPS. This source of data enabled us to understand how BPS was intended to work, and prepared us for the interviews to take place later. In one such meeting a representative from one of the production units of HAL was adamant in his opposition to implementing the BPS. His opposition to BPS was particular addressing the issue of "why do we need a new system when the old system is ok?" When the new system structure and processes was developed and organized into a prototype, this particular employee became one of the most fervent defender of the new system. In one of these planning sessions I was asked to present some of the experiences we had gathered from the development of a similar system in Statoil. In another meeting I was also asked to prepare a short brief on how we rolled out the system in Statoil. Here I participated more directly in the meeting. I have also participated in telephone conversations with the project leader and some of the managers. These have been one-to-one conversations were particular issues have been discussed. Some of these issues have been about power struggles with managers who, for various reasons, wanted to postpone the implementation; others have been in relation to selling in the message into the organization. A general tendency from these observations is that while employees see great opportunities in using the BPS system, some middle management sees hurdles and possible threat to their authority.

We also visited the production floor of both locations on some occasions. On our visits to the production floor we were able to observe some of the issues of importance pointed out in the work shops. This could include adherence to routines relevant for "clean shop," "safety," or "team discussions." In spite of the very good impression one gathered from visiting the production areas, with clean shop, "safe route" markings, etc., unwanted incidents and accidents did happen. Thus, management's push for experience sharing was relevant.

4.2.2 Secondary data

Through these secondary data we were able to understand how the project team planned to implement BPS, how employees would be able to train themselves in applying BPS, instructions on how to arrive at best practices relevant for their tasks, and what the purpose

and goal of the system was. But this source gave little insight into explaining how, and under what circumstances, best practice was developed. Thus, documentary data must be accompanied with interviews and observations. Here the primary data can be checked against the secondary data and visa versa in addition to bringing forward new and supplementing information.

Published

The company has published a set of documents describing the intention with the system. Particular HAL's intern magazine "Alu Magasin" has published articles on the system, employees' views of the system, management's intentions and the project group's work. External publications have been newspaper articles about HAL's strategy and its closure of production lines and sites. The point here is that while newspaper articles are writing about lay-offs, the project team is implementing the new system.

Unpublished

This includes the plan to develop BPS, as well as its development and implementation process. All in form of PowerPoint files. Furthermore, we have received Performance Audits as to how employees see the new system, as well as experiences turned into new knowledge due to BPS. We have also received e-mails referring to how best practice has been applied within the aluminum industry, illustrating the necessity of such system as BPS. We have copy of the internal handbook made in regard to the application of management systems implemented in Metal Products.

4.2.3 Longitudinal data

Our research project is a 3-year longitudinal study within a given industry context. While the unit of analysis is the case, such a concept cannot be treated as a single event or a set of discrete episode but need to be considered in a contextual and process view (Pettigrew, 1990). To achieve such a view we need to draw on vertical and horizontal levels of analysis (ibid). That is, we need to understand the antecedents that give rise to our phenomenon of interest - development of routines. We need to understand the relationship between management and operators, as well as between the operators. Furthermore, we need to understand what happens to the experience gained by our informants, that is, if and how the organization learns from such experience. And we need to understand how events occur after the new routine is being diffused and the implementation is completed. Thus, we will perform a multilevel longitudinal study. We were given access to management in order to solicit and understand their purpose and goals of the change of computer system. Furthermore, we were given access

to the organization before and after the official implementation of the new business system was completed. At the completion of the development period an evaluation was carried out by the organization for the purpose of finding out if the new system could be understood and supported by the organization. We were given access to a summary of that report. The process started in 1999, with the system development period 2002-2003, and implementation period 2003/4.

We followed the development and implementation process, that is, from 2002 to summer of 2005. We have in section 4.2 discussed the major requirements to the study. These requirements give further guidelines to which research design is most appropriate for this study. The research questions under investigation are interesting to study, as there is limited a-priori knowledge on the phenomenon. Thus, in order to get an answer to these questions, we will study the actual development process as it takes place.

4.2.4 Criteria for choice of cases

The case study is a research strategy that focuses on understanding the dynamics present within a single setting (Eisenhardt, 1989). Miles and Huberman (1994) define a case as phenomenon of some sort occurring in a bounded context, and the case is the unit of analysis. Yin argues that an explorative case study will have difficulty in developing hypotheses based on current theory (Yin, 1994). This is due to lack of substantial theoretical evidence. However, we still need to have some idea about what we would like to study, and which outcome such study may result in. According to literature, a-priori specification can help shape the initial design of theory-building research (Ghauri & Grønhaug, 2002; Eisenhardt, 1989). Furthermore, a conceptual framework and research question can help set the foci and boundaries of the study (Miles and Huberman, 1994:30). Thus, we have developed an a-priori research model (ch. 3). In order for our research to be focusing on the chosen issue, we developed a tentative perspective (Eisenhardt, 1989). We will conduct our explorative case research inductively, that is, develop variables influencing development of routines, rather than deductive research (Creswell, 1998). Inductive research can apply a range of data collecting methods, and apply quantitative data to qualitative analysis.

Case studies can consist of one or multiple cases. A common reason for choosing multiple cases is because this leads to greater possibilities for generalization (Leonard-Barton, 1990), while Stake argues that “generalizations from differences between any two cases are much

less to be trusted than generalizations from one" (Stake, 1994:242). Furthermore, a case may have units of analysis embodied within them (Yin, 1994). However, a single case study is subject to limits in generalizability and several potential biases, such as misjudging the representation of a single event (Leonard-Barton, 1990). It is possible, however, to increase generalizability by carefully choose the cases based on replication logic similar to experiment designs (Andersen, 1997; Yin, 1994). This study's primary aim is not to generalize findings to theory, but rather to test literal replication (Yin, 1994). In this study, the case is a useful foundation for comparing groups of actors related to the research question and thus creates possibilities of learning about the phenomenon during the research process.

We are performing a single case study comparing groups of actors within an organizational setting. Our two production units, Karmøy and Høyanger, represent different business activities and different team responsibilities. This makes it a multi-unit study. Sampling of multiple units adds confidence to the findings (Miles & Huberman, 1994). According to Yin, a single case with multiple units of analysis can be viewed as an embedded case study (Yin, 1994). By looking at the construct from several angles, that is using the two factory sights to create several units, we will achieve replicability (Yin, 1994). However, there are also some pitfalls in such an approach. The most important is if the researcher "fails to return to the larger unit of analysis" reducing the original phenomenon to "context and not to the target of study" (Yin, 1994: 44). We are applying the single, embedded, research strategy for choosing our case. Furthermore, based on the fact that we started with a holistic approach to this study, we should be able to end the discussion by returning to the organizational level.

The data collection is derived by structured and semi-structured interviews, observation, and from secondary data. We are using primary data, available a-priori information, as well as qualitative information converted to quantifiable data (Ghauri & Grønhaug, 2002). The purpose of multiple data collection is to secure triangulation, that is, use of multiple view points for greater accuracy - providing stronger substantiation of constructs and research model combining different types of documentation (Ghauri & Grønhaug, 2002; Eisenhardt, 1989; Jick, 1979). Furthermore, a within-method triangulation comparing multiple groups in combination with multi-source data will strengthen the case study's internal reliability (Jick, 1979: 603). An embedded, comparative, case study will also provide us with the possibility to do within-case analysis for internal validation, while our case study data base (protocol) will provide reliability (Yin, 1994). However, regardless of how much "hard" data we collect and

structure, it is only through the use of “soft” data we are able to “explain” them (Mintzberg, 1978).

In this study, the organization represents the case. One reason is that routine development has to be analyzed in its context, that is, where the phenomenon takes place, and where routine development is most likely found. Another reason to study organization as a level of analysis is to understand the influence, if any, a change of system could have on the employees’ ability to develop new routines applicable across the organization, and which impact management policy may have on the research question. Thus, longitudinal data from the implementation process constitute data in this thesis. We were given access to management in order to solicit and understand their purpose and goals of the change of computer system. We were also given access to two operating sites, two business units, and two functional groups of employees. Furthermore, we were given access to the organization before and after the official implementation of the new business system were completed. Therefore, in order to increase the likelihood of capturing several explanatory factors, a one–case analysis was chosen as the basis for this study. At the completion of the BPS *development* period an evaluation was carried out by the organization for the purpose of finding out if the new system could be understood and supported by the organization. We were given access to a summary of that report.

In choosing which cases to study, several dimensions can serve as selection criteria. Cases may be chosen randomly, but random selection is neither necessary nor preferable (Eisenhardt, 1989). Random selection of cases may not ensure that the research question of interest is present in the case. Pettigrew noted that in longitudinal studies normally a limited number of cases can be studied, thus we should be selecting cases that are “transparently observable” (Pettigrew, 1990). This means selecting cases which represent extreme situations or are polar types that will be useful for replicating or extending theory (ibid). Another factor that may influence the process of choosing cases is the mere fact of getting access to an organization. As mentioned above, access to an organization was given to us. But access to collect data for our first attempt on a research design was not possible to achieve. This was partly due to the fact that the number of units, employees and tasks required for its design was inaccessible at the time, and partly due to the delay of BPS being implemented by a year within some of the units of interest. Our contact in the firm did, however, secure access to

two operating groups, located in different geographic regions, representing two business units performing similar task activities - Karmøy and Høyanger.

As mentioned above, we were given access to a managerial group and two sites. During the first set of interviews among the employees we discovered that our informants came from two different business units - PM and MP, and represented two types of functions - production workers and staff employees. We had regular contact with both Karmøy and Høyanger during this period. The implementation of BPS at Karmøy and Høyanger PM was postponed. During the spring we were told it would not be implemented before year end 2004. Early in 2003 we were told that Karmøy was in the process of implementing BPS. Thus, when we came to Karmøy for interviews we assumed the implementation had gone according to plans, as we were told. We later learned that in Karmøy only Metal Products had implemented BPS during the spring/summer of 2003. The Primary Metal business unit postponed their implementation due to employee objection. In other words, the first Karmøy interview is pre-implementation. In spring of 2005 we did complete two post-implementation interviews, one in Karmøy and the other in Høyanger.

Hydro Aluminium, as the case, has been studied in this thesis. Choosing the corporation secures several similar factors. Governance system, incentive systems, and corporate culture are some of the factors that will not affect the result of this study, since they are identical across the groups. Limiting the cases to one corporation also means one new business system, BPS, will be in place in different settings. This represents a unique opportunity to examine the use of computer system as a support for routine development in different settings over time. However, the business units from where the groups of actors are drawn, is subject to different contextual and historical factors that will influence the routine development process in the units in different ways.

At the start of our interviews in 2002 HAL was in the process of negotiating a takeover of Germany's larges aluminum production group, VAW, making HAL the world's third largest integrated aluminum producer. We were told that some managers considered the amount of involvement of their organization required by our original design would have interfered with the merger activities. Clearly, the merger was a disturbance on the operating activities of HAL. Two additional "disturbances" for the organization during the interview periods were (1) international pollution agreement, and (2) hydro-electric power agreements between the

Norwegian authorities and the process industry. The pollution agreement required HAL to close the Søderberg production lines by 2007. This would impact both Karmøy and Høyanger's performance, but Høyanger more than Karmøy due to its lower production volume resulting in higher unit cost. The electricity agreement, having given the process industry lower prices since its origin, is planned to be discontinued by the government within a few years. These two external forces prompted speculations if Høyanger, and also possible Karmøy, would be closed down. For the Høyanger community this would mean huge unemployment, as it is a "one-company" town. A Canadian aluminum company put in a bid to take over the Høyanger factory, but HAL management turned it down, and decided to continue operating the units, while closing down the polluting production lines as agreed to. These external disturbances were the backdrop to the interviews.

In the second interview round we focused our attention to how teams developed routines more than on critical incidents. This refocusing of emphasis in the second set of interviews was in recognition that the issue of critical incidents did not shed much light on the phenomenon we tried to understand. Rather, if routines were developed by the employees, we wanted to know how and why. The implementation of BPS was postponed within the PM units in Karmøy and Høyanger, but not in MP. The reason for postponement was that they had to restructure the whole document hierarchy. This entailed that the Best Practice document structure should follow technology used to produce aluminum, and not the fact that all production units belonged to PM. Focusing on technology at the top of the information structure, employees were better able to navigate down in the document hierarchy. When we executed the second set of interviews in April 2005, PM had been using the new system for less than a year, while MP had been using it for a year and a half.

As we were starting to analyze the interviews we discovered that we could categorize the informants in four groups: Primary Metal, Metal Products - Marketing and Sales, Operators and Staff employees. We consider the four categories as polar type as they are historically, processual, and occupational different. For example operators work in the production halls, while staff works in offices where they have immediate access to computer. Work activities and the value creating processes are different between the groups, thus providing findings that should both replicate previous findings, but also give new insight to the issues of interest here. In addition to comparing the groups, we will also compare each group for the purpose of detecting similarities or differences in how routines are being developed through the

computer-supported knowledge representation. This will further be discussed in the next section.

The embedded cases will consist of four groups of actors (ref. table 4.2 below): Primary Metal (PM), Metal Products - Marketing and Sales (MP-MS), Operators (OP), Staff (ST). In 2003 PM consists of three employees in Karmøy and four in Høyanger. MP-MS will have one in Karmøy and no one in Høyanger. OP has one in Karmøy and two in Høyanger. ST has three in Karmøy and two in Høyanger. For 2005 PM consisted of two in Karmøy and three in Høyanger. MP-MS had two in Karmøy and nil in Høyanger. OP had one in Karmøy and one in Høyanger. ST had three in Karmøy and two in Høyanger.

4.3 Data analysis

Analyzing data is the most important, but least developed and most difficult aspect, in doing qualitative studies (Yin, 1994). All data analysis has to do with classification and data reduction, a process of bringing order, structure and meaning to the data. The difficulty is due to the data's complexity, composition and omnipotent, and thus demanding to analyze and difficult to get an overview. Thus, to make sense of the enormous amount of data from an explorative study that spans several years, we find the application of interpretation a necessity in order to abstract findings that have implication to theory building.

In this study we have applied a structured and systematic analytical process while we also aspired to have a close feeling for the data. This implies a laborious and resource demanding process where data was categorized and coded manually rather than using an analysis program, and where all the interviews were regularly perused for interpretation. This way we were, throughout the analysis period, forced to get "under the skin" of the data, which gave good suppositions for an in-depth understanding of the routine development process under study here. Such an approach also has limitations. According to literature, qualitative data analysis does not proceed in a linear process, but rather it is an iterative process between using theory and analyzing data in order to find answers to the research problem (Ghauri and Grønhaug, 2002; Pettigrew, 1990). The purpose of the following description of the analysis process and discussion is to give a best possible overview over this process, and as such prepare for a possible replication. The analysis process can be divided into different phases, and one can distinguish between preliminary analysis, within-case-analysis and across-case-

analysis (Miles and Huberman, 1994). We have produced a preliminary and a within-case analysis.

4.3.1 Preliminary analysis during data collection

Data collection had duration of more than three years, during which period we did preliminary analysis. Preliminary analysis is important in longitudinal study as "it enables the researcher to collect new data to fill in gaps, and to test new hypothesis that emerge during analysis" (Miles and Huberman, 1994). Starting with the CSF interviews in the fall of 2002, we printed out each interview and applied the CSF method for eliciting the participants' goals and the factors the managers believe are critical to attain the goals (Fuglseth, 1990). The data for each participating manager was categorized and fed back to each individual in order to have the analysis validated. In addition to serve as a context specific guideline for understanding the purpose of the implementation of BPS, the elicited critical factors were used in the construction of the case interviews. The basic structure of the case interviews was the critical incident technique (Flanagan, 1954). However, we also applied critical factors elicited from the CSF as basis for formulating questions for the interview guide. As each case interview took place, we printed out the result, read through it and contacted the informants where clarifications were required. As each interview was printed out we coded the text for significant statements and made a summary, splitting the sheet with questions on the left hand and answers on the right. This brought the lengthy interviews down to a fraction of the original size. This way the relevant issues coming out of each interview coded was systemized and reduced to a manageable set of data (Miles and Huberman, 1994). Structuring of the data and notes of reflection made it possible to find statements and other relevant data when needed for in-depth analysis at the early stage of analyzing the first set of data. After first interview we analyzed Karmøy and Høyanger, and structured the data according to that. We grouped them according to concepts, based on the structure in the interview guide, and the tentative research model. On this basis some empirical findings and tendencies became clear. These preliminary findings were presented to management in form of a PowerPoint presentation. The purpose of this presentation was in the form of a progress report on how the employees viewed the use of SDOCS and BPS.

Prior to the second round of interviews we adjusted the interview guide as mentioned above. After the second round of interviews, spring of 2005, we summarized and structured the results as we did for the 2003 interviews. Furthermore, we summarized the two set of

interviews as tables, and started a preliminary analysis by categorizing the interviews according to the interview guide, and thus prepared the primary data for the within-case analysis. We then categorized the units into comparable sets, as can be seen from the table below (table 4.2).

Plant / Function	Karmøy	Høyanger
Primary metal		
Metal Products		
Operators		
Staff		

Table 4.2: Categorization

Table 4.2, Categorization, is the basis for our analysis. We discovered clear discrepancies between the different members of the organization on how they interpreted the company's strategy with regard to participating in organizational learning leading to developing routines. This discrepancy was not necessarily a result of two geographically dispersed locations as we first had envisaged. We will now turn to the within-case analysis of the groups of actors.

4.3.2 Within-case analysis

When analyzing cases it is recommended to view each individual case in isolation from the others (Eisenhardt, 1989; Miles and Huberman, 1994). We will apply the same principle to the groups of actors, securing each group its idiosyncratic description. Each group has been described and investigated along the different dimensions and variables included in the research question and model, which reflects the questions we asked of the informants: (1) Understanding and use, and overall usefulness of the two systems SDOCS and BPS; (2) sharing and transfer of experience; (3) organizational learning; (4) experienced employees handling new routines and, training new employees; (5) employees views on empowerment, local democracy, and BPS' ability to create values; (6) developing routines. The majority of these questions are based on the goal of management, and in line with the cognitive/behavioral learning mechanisms of Zollo and Winter (2002) identified in chapter three.

According to Eisenhardt, the overall idea of the within-analysis is to get intimate familiar with each case as a stand-alone entity, which allows unique patterns of each case emerge before investigators generalize across cases (Eisenhardt, 1989). By writing a "story" for each group we can se similarities and differences within each unit. The story was written based on our tentative research model. The tentative model was used as guidance for making central themes or categories in order to organize the data, but throughout the inductive analysis we continuously evaluated if categories should be changed or added. Our story dedicated to each group focused on critical issues as referred to above, such as the ability to use computers, using computers for the purpose of extracting, and developing, routines. However, it also included some new categories. The within-case analysis thus far has provided a step in the analysis consisting of an analytical description of the organizational learning process seen in chapter three. It was analytical because it was steered by a theoretically deduced framework developed by Levitt and March. Figure 3.2 is a theory building perspective for a deliberate learning process and it organizes and focuses the description of the organizational learning content, context and process toward development of operating routines.

Some new categories or central themes evolved as we moved from 2003 to 2005. For example the issues of *participation* and *empowerment* emerged as concepts. The research question and model helped focusing the interviews and organized the data. However, only after the restructuring of the case are we seeing patterns which did not occur to the same extent when comparing two sites. Thus, by studying the organization as a case, with groups of actors within it to be compared, we may be able to answer the research question with more insight.

Based on the embedded case analysis, it was possible to develop further, and add specificity to, the study's original theoretical standing, and as such be able to add nuances to the existing theory for the understanding of how people develop and learned organizational routines. We found that the *organizational learning* theory in fact elucidated the routine development process we encountered in HAL. However, we may need to go to other theoretical basis to find the answers to *how* and *why* this may happen. The next step in the data analysis was to make more sense of the information at hand and use the data in order to probe the research question. In order to answer the research questions, new theory may have to be applied to the issue of what influences why computer-supported knowledge representation can enhance

routine development. We will move on to compare the groups of actors in order to get some answers to our research question.

4.3.3 Developing propositions

Based on the embedded case analysis and the comparison of groups of actors we are able to start formulating situation-specific and general propositions in relation to development of routines. As this is an iterating process we will be able to be more precise on the formulation of propositions related to our findings once we have completed our analysis based on inductive methods and relevant theory such as *deliberate organizational learning* and *multilevel learning*. We will be using a mix of description, supported by quotes and analysis. We will attempt to present the findings in themes around the research question. Chapter five will contain the compilation of data and analysis of comparisons, while chapter six will discuss the analysis, before we in chapter seven reach conclusions, implications and contributions.

4.4 Validity and reliability

The case study is an iterative process between data collection and theory. The evaluation of a thesis is normally done based on validity and reliability. Validity concerns the issue of measures, whether or not one has measured what one set out to measure, while reliability aims at securing that the study was conducted in a secure and reliably manner. The reliability is determined by how the measurement leading to the result is executed, and the term relates to the accuracy applied to the different operations in the process (Miles and Huberman, 1994). The case study is about capturing the complexities of the real world, and then making sense of it (Pettigrew, 1990). The problem of validity lies in the relevant linkage between the two "worlds" - theory and real, where the scientist's role is to secure an identical use of concepts on the theoretical and empirical levels. Furthermore, the interpretation made from the empirical data should be testable and readily available for others to judge. This implies clarifying the procedures used to ensure relevant methods and that conclusions are valid. In order to evaluate the quality of a research project a set of criteria should be applied to the evaluation of the study.

Common research evaluation criteria include objectivity, internal and external validity and reliability. However, there is no consensus within the literature whether or not these are

suitable criteria also to be applied to qualitative case studies, as they were originally meant for quantitative and theory testing approaches (Miles and Huberman, 1994; Maxwell, 1992). Objections concerns firstly if validity is relevant in case studies, and secondly which validity criteria should be applied. Regardless of the discussion it is important to enable others to evaluate the strength of the method and the evidence grounding the theory. Others need to be able to assess whether or not the researcher has followed a careful analytical procedure, whether evidence supports theory, and whether rival explanations have been ruled out (Eisenhardt, 1989). In the following we will apply criteria used for assessing the trustworthiness and authenticity of this research. They are: *descriptive*, *interpretive*, *construct*, *internal* and *external validity* and *reliability* (Yin, 1994).

4.4.1 Validity

Descriptive validity refers to whether the data is factually accurate and complete, while *interpretative validity* encompasses the researcher's credibility in the eyes of the research population (Maxwell, 1992). The implication of interpretative validity is for the researcher to refrain from forcing the researcher's own viewpoint on the informants through leading questions, or to reduce respondents' time to answer appropriately. Through taping of conversations, verification by the informants, and a description of the data collection procedures, we have demonstrated neutrality and openness in the data collecting process. There is a risk, however, that the informants will disagree with the researcher's interpretation of the data, particularly if the organizational members should be put in a bad light. As have been explained above, factual information was always corrected based on feedback from informants, and we had no disagreement of consequence with the informants.

The inherent limitation of case studies is the vulnerability of the data to a subjective interpretation and the difficulties of compiling own evidence about relationships among variables (Leonard-Barton, 1990). In case studies interpretations by the researcher are necessary. While objectivity is a virtue and should remain the goal, it is not viable to claim total objectivity. Therefore, it is important in qualitative studies to frame the empirical data within an analytical structure, and not let them be a result merely of the researcher's expectation and previous experience. Through this research's structured framework we believe this aspect has been complied with.

In this research we have tried to maintain *descriptive validity* by describing the structured framework for data collection and analysis, describing actual sequences for data collection and analysis for traceability, linking conclusions to summarized data, and providing detailed record of methods and procedures (Miles and Huberman, 1994). This is achieved through logging interviews, observations and documents as described in this chapter, and secure that summaries and analysis are maintained, and made available on request. Through triangulation, by using several sources of data, the objectivity for the data analysis strengthens. In this research these issues have been dealt with through striving to ensure both descriptive and interpretive validity.

Construct validity and *internal validity* are two other criteria for validating the research. The development of a tentative research model based on a-priori specification of constructs increases construct validity because it allows more accurate measurements of the constructs (Eisenhardt, 1989). However, it is only through such 'data-driven' mapping, that is, an iterative comparison between empirical observations and constructs/theory that we can arrive at a final model and set of propositions (Ghauri & Grønhaug, 2002). Such development of propositions strengthens construct validity (Eisenhardt, 1989). Multiple sources of evidence and multiple indicators serve to increase the validity of emerging concepts. For example evidence of employee-management dialogue in best practice development found in interviews with employees could be backed up by similar evidence in policy documents. Statements concerning the postponement of the BPS implementation in PM could be coupled with statements concerning empowerment, and such indicators strengthened the evidence that employees both participated in routine development (take responsibility) and was empowered to do so.

Internal validity is concerned with the causal relationship among the variables, and that such relationships are non-spurious (Yin, 1994). A major problem related to qualitative research is that internal validity is often not easily determined; limiting the importance in explorative or descriptive studies (Sykes, 1990). By increasing the quality and thoroughness of documentation and the description of data, together with collection, preparation and analysis processes, internal validity can be strengthen. Furthermore, a longitudinal, real-time study can also increase internal validity by enabling one to track cause and effect (Leonard-Burton, 1990). Such real-time study can also make one become aware of intervening variables.

Documentation related to increase in number of new routines could be coupled to statements concerning increase in number of experience sharing as the organization makes enabling technology available. Likewise will comparison with conflicting literature strengthen internal validity (Eisenhardt, 1989). Statements concerning an operator's ability to learn while reading a new process on the overhead projector can be compared with a conflicting statement related to learning taking place through master-apprentice relationship within a community of practitioners.

External validity specifies the usefulness and transferability of the findings (Yin, 1994). The case studies are not samples and do not rely on statistical generalization but on analytical generalization (Yin, 1994, p. 36). This implies that we will attempt to elevate our findings to a higher level of abstraction, rather than to larger population as is the case in quantitative studies (Yin, 1994; Eisenhardt, 1989). Since case studies rarely rely on random sampling, generalizing to a larger population is seldom a goal in these types of studies (Yin, 1994). The usefulness to other researchers then can be questioned, as further research is dependent on the theory's generalizability and its external validity.

The objective of this research is to generate knowledge on how organizations develop routines. The replacement of one computer system with another has allowed us to compare groups of actors within a single organization (multiple units of analysis) which has resulted in a comparative case study. We follow groups of actors over a three-year period where we explore if, how and why this phenomenon occurs. Through a comparative analysis both context specific and general propositions will be developed. The purpose of these propositions is to do the study's empirical findings more generalizing, while being cognizant of the fact that "case study is not a methodological choice, but a choice of object to be studied" (Stake, 1994, p. 236). We hope to contribute to the general understandings of the phenomenon because we are interested in the phenomenon.

4.4.2 Reliability

Reliability refers to replicability - whether or not another researcher, following the same procedures, will arrive at the same conclusions. Interpretation of data based on such categories as "Supportive", "Unsupportive", and "No Opinion" will have to be subjective. Furthermore, revealing the raw data may jeopardize the confidentiality we have guaranteed

toward the informants. Also on this subject the literature is divided on the relevancy of replicability as a goal in qualitative studies (Miles and Huberman, 1994). Yet, most scientists acknowledge the need for the research and its conclusion to be as exact and descriptive as possible in order for others to evaluate and assess its reliability. Based on our insight we have attempted to the best of our ability to represent the views and actions of the informants in a most objective manner.

Measurement structure

In order to narrow down the fifteen semi-structured interviews made by HAL employees in the period 2003-2005 we summarized them by issues described in the interview guide (Appendix C). Furthermore, being able to coordinate the answers in the semi-structured interviews, we developed a simple measurement system: Supportive, Unsupportive, and No Opinion. We defined the three measurements as follows:

- Supportive (S):
    - Strongly favorable to somewhat favorable to the issue in question.
    - When reading an informant's answer, we interpret it in light of the impression we have of the informant, and the strength of the statement's positive aspect.
- Unsupportive (US):
    - Strongly unfavorable to somewhat unfavorable to the issue in question.
    - When reading an informant's answer, we interpret it in light of the impression we have of the informant, and the strength of the statement's negative aspect.
- No Opinion (NO):
    - The informant eider did not answer, did not care about the issue, or did not offer an strong opinion one way or the other.

We could have made a more stringent coding system with a larger scale. However, under such a regime the questions had to be much more rigid. We choose the semi-structured questionnaire for the following reasons:

- The research is explorative
- The questions were semi-structured and thus open to interpretation by the informants
- When making a narrative one has to rely on own interpretation and judgment

- Having insight into the issue one is capable of at least judging the answers into a rudimentary structure
- We are in this study not attempting an experimental design

Thus, we felt the three-prone segmentation of the answers to be sufficient.

Comparative groups of informants for analysis purposes

We wanted to compare groups of informants with regard to *employment* and *function* relative to *location*.

- Location:
  - Karmøy
  - Høyanger
- Employment:
  - Primary Metal (PM)
  - Metal Products (MP)
- Function:
  - Operator
  - Staff

4.5 Summary

This chapter probed methodological issues. The first part of the chapter dealt with the selection of research design and requirements to the design. An explorative study was found to be the most appropriate based on the requirements to the research questions. As there is limited a-priori research on the specific phenomenon of interest in this thesis, a ***longitudinal case study*** design was chosen to meet the following demands:

- Reveal possible routines development over time as a result of introducing different ICT regimes
- Need to be able to explore reasons for routine development over time
- Need to be able to evaluate the effect ICT regimes have on routine development
- Access to an ICT implementation process to be able to monitor any changes in use over time
- Possibility to rely on existing research which is limited and fragmented, yet informative.

A large Norwegian company, Norsk Hydro's daughter company, Hydro Aluminium a.s (HAL), was selected as the research setting and level of analysis. Within HAL two plants were chosen for an embedded case study. Data was gathered from numerous sources, such as interviews, observations, and archives. Organizational members at three levels, HAL, plant management and operators, were targeted for interviews. The unit of analysis was ICT-supported routine development. Different analysis of the data was also described, such as preliminary analysis during data collection, within-case analysis, and validity and reliability. The methodological descriptions and challenges presented in this chapter is an attempt to increase the reliability of the study.

The aim of this chapter has been to present the data collection and data analysis in a chronological manner. The goal has been to be clear about the methodology by describing exactly how the research was performed, step-by-step and as specifically as possible. The findings will be presented in accordance to the research problems described and analyzed. In chapter five the findings will be reported. In chapter six we will discuss the findings and in chapter seven conclude the research and suggest implications and future studies.

We have in this chapter strived to give a diligent description of the research process, and the justification for the choice of method. This includes both choices of case and collection of data. Furthermore, all relevant and accessible information and sources in form of interviews, reports, literature and other materials be listed in the appendix and literature list. Not having applied a general accessible computer program for analysis purposes represent a weakness when it comes to the reliability of the study. This implies limitation to replication of the analysis process. Nor can one exclude the possibility that the choice of cases and the subjective nature of interpretation of data that follows a case study may exert a weakness and limitation to the study's reliability. However, based on the study's purpose and goal these sources of error have been minimized throughout the process.

5 Reporting findings

According to Yin (1994), case study analysis is difficult. However, by structuring the data and make them "quantitative by coding events into numerical forms … may be possible when one has an embedded unit of analysis within a case study" (p. 103). This being said, Yin argues that a general analytical strategy is "to produce compelling analytical conclusions, and to rule out alternative interpretations" (p. 103).

This chapter reports and analyzes the findings. We will discuss the SDOCS and BPS systems in lieu of management intention, its purpose, and deliberate approach to learning resulting in improving/developing new routines. We are particularly interested in understanding how learning mechanisms were enacted through the support of ICT, and show how each embedded unit acted as part of a larger organization through nested iteration. While we, at the outset of this research, did not envisage management's view on empowerment we were able to include it in our second round of interviews. We will analyze the results of such policy. Based on our primary and secondary data we will also analyze the application of the deliberate learning model (Zollo and Winter, 2002) implemented by management with empirical evidence to see if employees are enacting the learning mechanisms to fit the model. Furthermore, based on Argyris and Schön (1996) single and double loop learning model, we will relate the resulting learning product to improvement in operating routines/strategy, as well as testing empirically Crossan's et al. (1999) multilevel organizational learning process. Also, a primary work of this thesis is to see if Huber's (1991) application of computers as organizational memory can lead to organizational learning and development of routines through the ICT-supported knowledge representation. Finally we will test out the operationalising of management's strategy on implementing BPS, and identify to which extent empowerment and knowledge management may, if any, have had on its strategy.

We will demonstrate a nested deliberate learning process which we believe is a natural consequence of deliberate organizational learning, empowerment, and knowledge management, and which is lacking in the applied literature. Furthermore, we will demonstrate how and under which circumstances organizational memory support organizational learning and development of single and double loop routines. Our intention is to carry out a structured and systematized analysis of the embedded cases which consist of an abundance of data. This will be achieved by first writing stories about our informants' mastering of the challenges

related to this study, and secondly by establishing some kind of overview of a complex process of routine development by quantifying the answers given by the informants.

From chapter one we learned that HAL management had implemented empowerment in the organization, provided collaborative computer technology within the organization and through these actions anticipated organizational learning leading to development of routines and enhanced value creation. With "collaborative" we imply a technological solution of interactive communication using internet/web technology. Based on the cognitive/behavioral organizational learning theory (chapter 2) and the deliberate organizational learning theory (chapter 3) we will analyze our data in relation to computer-supported organizational learning, the learning mechanisms, multilevel organizational learning, single and double loop learning, and the relationship with empowerment and knowledge management.

This chapter consists of five elements: 5.1 will try to uncovering management's intents through the CSFM (Critical Success Factor Method) interviews; in 5.2 we will tell stories of how employees enacted BPS, learning mechanisms, new routines, single and double loop learning, empowerment, and system design participation. In 5.3 we will report findings through statistical data sets, analyze these data in relation to our respondents and discuss different attitudes, cognitions, participation in the various systems, and consequences for such different participation.

We will apply a number of statements from the many informants as well as from written sources, and this represents an explicit methodical choice. We will combine quotations from individuals with numerical summaries. The purpose is to document and give detailed illustration of mechanisms and processes discovered in the study, and thus comply with the study's validity demand (Miles & Huberman, 1994). In an embedded case study each unit will be described in relation to the analysis process. Furthermore, by applying subunits, "an embedded design can serve as an important device for focusing a case study inquiry" (Yin, 1994:42).

5.1 Management intent - the results from CSFM interviews

A central assumption in this study is management's decision to empower employees to participate in best-practice development by both offering greater say in the affairs of operating the business and by providing employees with an "in-house" developed ICT tool securing an

effectuation of such policy. In return, management expects the employees to support the aim of the organization - being a “world class” aluminum supplier. This implies sharing experience, developing new routines and faster implementation processes, delivering highest quality and service, with minimum rework. A prerequisite in management literature for a system to be adopted by the organization is management’s genuine interest in, and support of, such implementation (ref. Kotter, 1996). In order to eliminate possible lack of senior managerial support for the application of BPS, we started off this research by doing CSFM interviews within the management group.

At the time of the interviews the informants belonged to three groups within HAL: Primary Metal (PM), Metal Products (MP) and Corporate Staff (CS). The two managers at Primary Metal had been in their position since before the start of the BPS project back in 1999. However, the Corporate Staff director had been with Metal Product up to a year before our interview. It was this manager, at the time Commercial Director for Marketing and Sales, together with the Project Manager, both belonging to MP, who was responsible for initiating BPS. Sector President, PM, became their strongest supporter for getting BPS developed and implemented. The last two of the informants were production managers in Karmøy and Høyanger PM.

The CSFM can be divided into two elements: The goal of the informant and the success factors required for reaching the goal. The informants’ goals can be divided into two main areas of interest: Effectiveness and efficiency. Long term return was important for effectiveness. Sector President indicated a 12% return on long term capital. This should be achieved by efficient production, technology development and the development of a knowledgeable organization.

> *Our operative goal is to make as much aluminum as possible to a lowest possible cost with the production equipment we have, without putting our employees and the environment in harms way*. (Sector President, PM).

HAL needs to apply the organization’s knowledge more efficiently so that the organization can increase aluminum production without adding new facilities.

> *We cannot build new capacity just like that. If we do, that means we will get a reaction in the market and the prices will dive.* (Sector President, PM).

How, then, will these goals be met? Looking at the critical success factors listed by the Sector President, we find four main areas of interest related to our inquiry: Value Based Management, Learning and Training, Best Practice processes (BP: organizational process for developing routines) and Best Practice System (BPS: ICT-system supporting routine development). The Sector President summarizes the CSF with a model (fig. 5.1) pointing out that organizational development and learning is the direction in which HAL must be mowing in order to achieve its goals. This implies an integrated development of all production units, where "common solutions" for units applying similar technology will be the norm, and where the best-practice solution, enabled by the BPS, will lead to "*fastest possible diffusion of good solutions*" (Sector President, PM, p. 17).

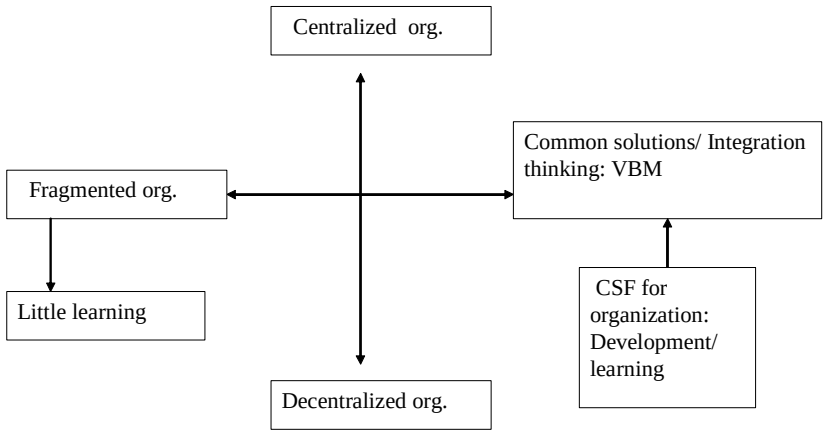


Figure 5.1: Value Based Management

According to the Sector President, PM, the "Common solution" and "integrated thinking" (integrasjonstenkning) is based on a so called Value Based Management (VBM, ref. Fig. 5.1). The VBM philosophy in Hydro consists of four elements (document): The Value of Shareholders, Community, Customers, and Employees. The Employee Value element relates to Motivation; and healthy employees being able to run assets and processes well. Based on this philosophy, senior management interprets this to include:

> *increased ownership to the value creating processes, increased empowerment, matrix management, and motivated employees willing and capable of learning. (Sector President, PM).*

Senior management believes these CSFs will lead to the organization learning to share experience, apply each others solutions and avoid "finding up the wheel" each time a plant has a problem.

> *Previously we thought productivity related to aluminum production was black magic, but in reality it has to do with competency, the ability to optimize all the technological dilemmas when producing at max capacity.* (Sector President, PM).

Central to the executive group in HAL is the development of competency and sharing new knowledge through experience accumulation, articulation and codification. In the Metal Product's Handbook of 2003, the Sector President of Metal Products says the following (document):

> *To continue developing Metal Products, we acknowledge the employees need to have a good and common understanding of our business. … We believe in the value of each other's ideas and in acting together to turn the ideas into better products and processes.* (Sector President, MP).

This is followed up, in April, 2004, by the CEO commenting on the firm's store of knowledge (document):

> *We will have to make sure that this does not remain a talent of individuals, but that we share it within our organization and makes it a Hydro Aluminium competence.* (HAL, CEO).

When BPS first was discussed in 1999, it was a local Karmøy project. As HAL moved from geographic decision-making units to sectors, the project first became a local PM/MP project. However, as it had not yet been officially approved by the management group, the project manager, and his supporters in MP and PM, was depending on some form for support by the four Norwegian plants + HQ. At the height of the development process during 2002, it became clear that employees' acceptance of BPS was going to be a problem. After all, the old system of SDOCS functioned.

> *If the system is not satisfactorily developed it will be full stop. And if it is full stop Karmøy will be the only unit which will apply this solution.* (Project Manager, BPS).

This manifestation of a need for a system to mach the Value Based philosophy engaged management (Røvik, 1998:118). In 2003 the executive group gave an oral acknowledgement for establishing a best-practice system, and later a statement by the CEO was made where he

asked for the system to be implemented across the organization. This "*fastest possible diffusion*" of BPS became a reality in HAL, and was now part of the institution.

In conjunction with the approval of developing and implementing BPS, senior management also agreed to an organization model making Sector Presidents process owners for their respective business processes. Its significance lays in the way experience will be processed through the organization. By being lean and iterative (see fig. 1.3) the organization becomes nested. This reduced hierarchical route for developing routines is a result of senior management's strategy to increase employee participation.

However, an approval by the executive group does not mean that the middle management is in line with senior management. To test the resolve by the middle management we also interviewed two operating managers. One manager at each of the operating sites in Karmøy and Høyanger was interviewed, in addition to a Sector President, the Project Manager, BPS, and his superior, Commercial Director, MP. The latter became Assistant Director, Corporate staff. Based on the analysis of the CSF interviews, there is a consensus between all four of the middle managers when it comes to the executive group's primary goals. This consensus is related to the issue of applying and improving best practice through BPS.

Based on the CSF interviews of middle management, there is a commitment related to the implementation of Value Based Management, Learning and Training, and developing BP and the BPS. Furthermore, the project manager, BPS, is strongly focusing on getting his job done.

> *The purpose (of the BPS) is to enable transfer of knowledge between the units. Furthermore, BP shall be transferred to units which do not perform the best … and on this basis establish a common area of discussing best practice".* Furthermore, the purpose of BPS is to "*secure colleagues recognition, secure their jobs, and the jobs for future generations".* (Project Manager, BPS).

According to Project Manager, there were middle managers, however, who did not supporte BPS at the outset. In telephone conversations with him we learned that 2003 was particular bad on this account. That is why the CEO and the executive team informed the HAL organization to apply BPS. On the basis of our interviews, and statements issued by the CEO, we conclude that there now is consistency between the executive and the middle management groups regarding a consensus on the purpose of incorporating BPS into the HAL organization.

Furthermore, in view of the statements from senior management group, we deduct that the system was accepted by the organization.

BPS is a deliberate learning system which purpose it is to support organizational learning and routine development, and as such improve or change the value creating processes in HAL. On this basis we *anticipate* that the implementation and application of BPS is accepted by employees and that the system will enable employees to improve operating routines in HAL. Our case study seeks to uncover how knowledge represented through a computer-supported deliberate leaning system can improve routines.

5.1.1 Nested deliberate learning model

In this section we intend to demonstrate how HAL achieve new/improved routines through the support of computer-stored knowledge representation. We will present a model (figure 5.2) of BPS as explained by management, depicting a structured process cycle of improving/renewing operating routines reflecting HAL's development process. Management wanted to see best practices developed through the support of knowledge represented in a computer system, a process not supported by SDOCS. The new BPS system is the result of a deliberate decision by management to support development of routines by having employees' experience articulated and codified into a structure of organizational memory. Such codified knowledge can be stored into a computer system for diffusion and implementation by employees (Zollo & Winter, 2002; Crossan et al 1999; Argyris & Schön, 1996; Huber, 1991; Levitt & March, 1988).

Through figure 5.2 we will demonstrate how HAL's BPS can support the development process by supporting the learning mechanisms, deliberate organizational learning, and nested iteration.

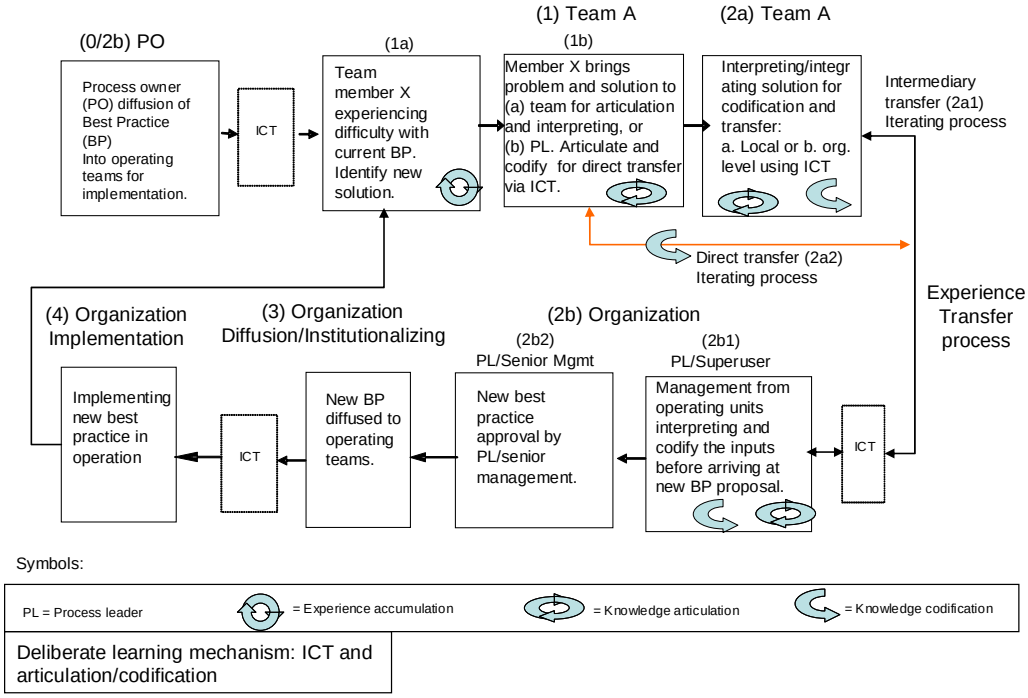


Figure 5.2: BPS - Nested deliberate learning cycle.

Based on the interviews with management it is our aim here to identify where in this deliberate organizational learning process, instigated by management, the system supports the learning mechanisms and nested iteration. By comparing this process to the experience made by the users we will be in a position to evaluate the success or failure of management intent. Superimposed on the development stages in figure 5.2, identified with numbers 1 to 4, one will find the three learning mechanisms identified with a *round cycle* for experience accumulation, an *oval cycle* for knowledge articulation and a *half cycle* for knowledge codification. The starting point is at the upper left hand of figure 5.2 indicated by "0/2b": Management issues the initial documentation for producing aluminum in HAL and stores it in the computer system (ICT). It is being distributed to all the members of the organization working within the relevant sector. Upon receiving a new routine, each team member undergoes a learning process.

As the members' starts applying the new routine (1a), the accumulated experience may lead to an opinion that the process can be improved, changed, or even dropped. In 1b the employee does one of two things: (a) share experience, through articulation, with team; or (b) work with articulation of own experience through a cognitive process for transfer to a process leader. In

2a a process of further articulation takes place in situations where the team members can add substance to the initial shared experience. Once completed the team discussion leads to codification (2a1) for transfer to 2b1 (here called intermediary transfer due to the intermediary step of team discussion before reaching PL/Superuser). Knowledge articulation has been identified to take place in 1b, 2a, and 2b1.

The final learning mechanism, knowledge codification (KC) is executed in two ways: (1) by the employees/teams (2A1/2A2) having reflected on their experience, encoding that knowledge for transfer to PL/Superuser, or (2) by PL/Superuser (2b1) articulating and codifying a proposal to be sent (back) to the business unit for comment. Based on feedback from operators PL will codify knowledge by changing/replacing the routine. In addition to approving the new sector-wide routine, each member will also be informed of the change through an e-mail. At the same time as the process moves from experience accumulation to knowledge articulation and codification within the team (horizontal direction), it also moves vertical, involving business unit as well as the whole sector/organization, all while the *deliberate*, *computer supported*, *learning* system is being enacted. The structure of the hierarchical learning process, institutionalized for the purpose of developing operating routines, provides a system supporting oral and written dialogue between employees and management.

Updating a sector-wide best practice routine is a management function. In figure 5.2 PL represents management and is responsible for such updating. Responsibility for the local business unit's best practice has been delegated to a Superuser who is the local representative for PL. Change proposals for local practice routine can only be executed by the local Superuser. For an experience to be converted to a new or modified routine, communication between the individual/team and PL/Superuser starts once PL/Superuser has received a proposal. Sometimes such proposal remains local, and will be implemented at the business unit level. Sometimes an experience is valuable for the whole sector, at which time PL initiates an iterative and nested dialogue with the local employee/Superuser using BPS. The dialogue is a method for securing that PL understands the proposal, as well as to test out uncertainties or own views. At this point both Superuser and PL have learned about the experience. However, organizational learning is taking place first when the accumulated experience, with or without adjustments by the PL/Superuser, is approved by PL/Superuser for diffusing into the business unit or the organization.

Through this model we have demonstrated how a multilevel nested deliberate learning cycle functions in HAL. We have pointed to the fact that for an ICT system to support organizational learning management needs to implement such a system deliberately. We have identified (fig. 5.2) how all experience is shared with group/management through nested iteration. Furthermore, through the early part of our study we made some additional observations. For the model to function two other management-introduced elements were identified: participation and empowerment. Management actually restructured the organization in order to receive codified experience, collaborate with any employee in an iterative process, and thus allowing employees to influence the development of both processes and technology. Model 5.2 also incorporate these two elements in the process description. Processes included the operating routines and production processes, while technology included both production technology and design of computer systems.

5.2 Replacement of SDOCS with BPS

In this section we will give a narrative of the users' view of BPS in comparison to SDOCS. But first we will give a short review of the design and implementation process. In section 5.3 we will report findings by tabulating the results from the semi structured interviews.

5.2.1 Design and implementation of BPS

As mentioned in chapter 1, the project started out by inviting employees from the different sites and units to participate in the design of the system while the technology development was the responsibility of an IT company. The project team being responsible for design and implementation was summoned to HAL's offices at the Karmøy site. Here they were going to lay the premises for how the new system should function, what the content should be and other requirements related to the system. Furthermore all current routines should be reviewed and adjusted to the new operating structure, focusing on business and work processes. One of the team members coming from a HAL site in eastern Norway, a region with long Hydro traditions, was in the early design phase very vocal about his opposition to any new system. In one of the early sessions where we were present this employee was very argumentative. He could not understand why HAL needed a new system to store a common set of routines and the process of developing new ones. SDOCS was good enough. His opposition lingered on well into the design phase. But as the development process was nearing its completion, this employee suddenly turned around. According to the Project Manager *"he became one of my*

strongest supporters of the new system. As he was testing out BPS he realized that this system could help his colleagues in making a better job and making the workday easier through the use of computers". Once the employee realized the value of his contribution he became a defender of BPS, and brought his new-gained insight back home to his colleagues.

The project group planned the implementation by scheduling a series of meetings and training sessions at the different sites. The first site to be tested out was Karmøy, chosen as a pilot site. Some of the users in Karmøy had also participated in the design team. They all supported the implementation and use of the system. As the development team started the implementation process, the BPS' project manager made the following statement:

> *"Our interest is the changes in BP (Best Practice) routines. According to the interest of HAL's management group, good experience must lead to improvement of BP for application throughout the organization"* (Project Manager, document, 12.04.05)

Each of the members in PM at Karmøy was introduced to the system through both classroom instruction and computer-based tutorial. After the completion of the implementation process in PM Karmøy, the project manager was very happy. This happiness was grounded in an after-implementation survey of the participants' attitude toward the new system, carried out by the personnel office. He told us that not only had the users understood the system through the coaching process, but the whole learning process took only a few hours. Furthermore, most employees also followed the easy to use electronic tutorial after the coaching process. This tutorial was directly linked to the operative BPS, applying real-time data. This way the online tutorial became a more realistic process. According to Project Manager very little discussion took place among the employees when leaving the old system.
We will tell the following stories:

1 Primary Metal, Karmøy
2 Primary Metal, Høyanger
3 Metal Products, Karmøy

Primary Metal, Karmøy

Our first interview in Karmøy was carried out at the end of the implementation process in the summer of 2003. Our informants were all praising the new system. Asking about the comparison between SDOCS and BPS the informants preferred the new system, confirming

the survey results. One of the informants came from the fore-warming team responsible for a particular segment of the production process. The team is responsible for making production cells ready for aluminum production, and give support to the shift teams which are keeping the production on a 24-hour continuing basis. The job of the fore-warming team is important in the sense of securing a speedy start-up after an overhaul of a cell, bringing a cold cell up to its production temperature around 1050 degrees Celsius. The faster the cell can bee ready for full production the more it will produce. Under such extreme operating conditions you need full focus and correct routines available. Prior to a routine activity our informant will enter BPS for down-loading the current routine to be applied against the work process. By accessing the relevant page in BPS he gets access to all relevant information through intra and internet links. Such information can be a detailed description of the routine with audio/video documentation, links to official procedures, and technology suppliers.

In 2003 our informant had been with HAL for about 15 years, and regarded himself as an experienced operator. Although he had been participating in the design of BPS he was not one hundred percent satisfied with the new system, although it was better than SDOCS in many ways.

> "*I use the system today, particular HES, which I consider to be very good. (However) if you click yourself in on operation such as "change of anode" it is all jumbled up. It should have been for each location. … Also, SDOCS was more detailed on operation. You could follow a job from A to Z. In BPS it is much more scattered on different places* " (Operator, PM, Karmøy).

But other informants, particular those employees having been transferred from production to staff positions, such as in personnel and HES, thought very highly of BPS. Another informant (Karmøy, 2003) joined the BPS design team with responsibility for HES (Health, Environment, Safety) argued for the need to replace SDOCS.

> *"SDOCS is inaccessible even if the operators have access to a PC"* (Staff/HMS, PM, Karmøy, 2003).
>
> *"While a safety plan should only have one instruction page regarding "WARNING" SDOCS needed several pages and was therefore both unsafe and inaccessible"* (Staff/HMS, PM, Karmøy, 2003).

An informant in MP supported her colleague in PM regarding their view on SDOCS:

> *"In SDOCS same procedure was spread around in many documents"* (Staff, MP, Karmøy, 2003).

HES being a sector-wide area of responsibility, our informants' concern were a better representation of routines on the computer screen, and faster overview of health, environmental and safety issues. Furthermore, the aim of HAL's management was to have all employees work within the same HES routines. A cross-company common understanding of HES is not only desirable, it is profitable too. By offering a more visualized display of, and easy access to, the relevant information, BPS will not only support employees under emergencies, but can also function as a preventive tool. With management's increasing focus on HES employees can now practice both operating and emergency routines prior to an operation. Furthermore, SDOCS did not support experience feedback, that is, accumulated experience returned to a process owner. From our informants it is clear that these objectives have been reached with regard to BPS. Thus, when our HES informant becomes part of the BPS design team, these issues - ease of access, of understanding and feedback, was important features to get into the design.

> "*If I was a new employee in need of finding "EMERGENCY" in BPS, I believe I should manage it and also finding the information satisfactorily*" (Staff, HMS, PM, Karmøy, 2003).

Also our informant in the fore-warming team considered the HES process in BPS useful. As this is not his normal area of work the operator needs to consult the HES process from time to time. For this consultation he uses BPS.

> *"I consider the HES system in BPS good"* (Operator, PM, Karmøy, 2003)

Ease of access, of understanding and feedback, were also among the important features for Process Owner's representative in the design team and our informant in PM, Karmøy, 2003 interview. With its large operation, HAL is in constant need of new recruits being introduced to HAL's operation. Furthermore, for PO it was also important that BPS supported experienced employees' wanting to upgrade their knowledge. Prior to BPS all training was done on PowerPoint presentations. Now it is possible to integrate on-line operating activities with training material.

> "*I participated in the development of BPS. It is not implemented as a complete system yet. … In BPS you can follow a job from A to Z, from receiving the order to delivering a product - that is what BPS' strength is; logical form, following the job the way you do the job*" (Staff, Personnel Coordinator, PM, Karmøy, 2003).

Furthermore, after having tested out BPS on a group of trainees in the early summer of 2003 our informant also made the following statement:

"*BPS is a unique tool for training new employees. We are using it now. It gives the trainees a good overview of the complete job*". (Staff, personnel coordinator, PM, Karmøy, 2003.)

One thing is the training of trainees under controlled conditions; another thing is using the system out in the operation. The production area can be dangerous for a new employee. Thus, in order for the trainee to be allowed into the area, the operators must be certain that the trainee is capable of understanding the routines. Also her BPS seems to better represent organizational knowledge than SDOCS. Returning to our informant in the fore-warming team, they needed a tool for both upgrading themselves and training new employees.

"*New employees can log into BPS and look at 'making cells ready for aluminum production' to learn how to do it*". (Operator, PM, Karmøy, 2003).

Previously all offices within each production area had a paper system for upgrading routines. A staff was responsible for sending out all new or changed routines. It was the responsibility of a foreman to replace the old with the new in the ring-binder. Although not yet replaced, the company has as its objective to replace the ring-binder with an electronic version. With BPS you don't have to load down the whole manual for a printout, as in SDOCS. BPS is organized to take out the relevant part of a routine. When a new routine is introduced electronically employees will be given an orientation by a foreman, often in a morning meeting where the foreman loads down the new routine from BPS and expose it on a video screen. This is the only information you get about the new routine, in addition to down-loading it from BPS. Those who miss the meeting need to learn it through BPS. Thus, it is important for HAL to be able to present new knowledge through BPS in a way that enables the organization to learn.

"*The foreman goes through a new routine by using a canon and an overhead screen on the meeting room. Here he brings up BPS to illustrate how the job is supposed to be done. He reads up the instructions written in the text area. If we want to repeat it we have to go to a computer and log into BPS. He does not give out a printed paper. Those who do not know the operation is getting his training her. … This is the only form for training we get. We are able to understand the new routines because we are experienced, we understand it intuitively. It may take a little longer if we don't get an instruction first. But when it is clear for us what the task is meant to achieve we understand it.*" (Operator, PM, Karmøy, 2005).

So, when our informant studies the new routine, does he feel like a newcomer to the company, we wanted to know? No, he did not feel like a newcomer. His experience gave him relevant background for understanding new routines presented in BPS. So did those who learned BPS from the computer program. The Superuser, PM, Karmøy (2005) and her colleagues, after a short presentation by one of the members of the design team, were able to learn BPS functions by applying the interactive learning presentation.

> *Even though it was a new system for me, as an experienced IT user I felt comfortable using it. I did not feel like a newcomer who had to learn to use a data program for the first time. I am using it now as I go though a one-to-one round with a foreman. I will print out the routines used within his work processes and I will be learning about those routines from the documentation found in BPS."* (Superuser, PM, Karmøy, 2005).

Together with a foreman the Superuser will go through the work processes, by walking the floor within the foreman's area of responsibility, to look for possible abnormalities regarding the application of current routines.

Sharing of experience for the purpose of improving operation is another issue in relation to the PM, Karmøy unit. Sharing experience is vital for the company's survival. But it is not enough to share information; good experience must be turned into better routines. That is part of the BPS strategy. However, getting people to share and return accumulated experience to the process owner or the team is not something everyone believes in.

> "*It depends on the shift. Some shifts are very good at sharing experience while others could be better at it*." (Staff, PM, Karmøy, 2003).

Most groups within the HAL organization seem, however, able to articulate accumulated experience to their colleagues or bosses.

> "*When someone brings up a suggestion for improving a process it is being shared and discussed among the shift*." (Staff, PM, Karmøy, 2003).

Within the fore-warming group experiences are shared and discussed.

> "*It is normal to share experience within our group*". (Operator, PM, Karmøy, 2003).

Experience is not only shared and discussed; the result is also written down and sent to a supervisor or process owner if the team finds it useful. Here BPS seems to be superior to SDOCS. In SDOCS you could not write anything down, either to store in own file or for

sharing such information with others in the organization. This is changed with the introduction of BPS.

"Yes, it is easy for me to register experience in BPS" (Staff, PO, Karmøy, 2003).

As an example on how an operator accumulates, and codify experience we can review our operator informant's participation in the search for improving the technology used for forewarming of cells.

> *"I went into BPS to find out what they had done on this new technology – gas fore-warming of cells. I started registering my experience with the gas fore-warming project using BPS. … I know of others who also use BPS for registering and looking for information"* (Operator, Karmøy, 2003).

All adjustments to, or alterations of, routines are to be codified and stored in BPS. While it is management's responsibility to store improved or new routines in the relevant work-process area, employees, such as the fore-warming team, are encouraged to participate in this process by making proposals based on experience. All employees in HAL can enter BPS through his/her computer in order to find upgraded routines related to a relevant work process. This new knowledge also contributes new (raw) information that can provide the diversity needed to start a new development cycle. For our informant in the fore-warming team, BPS was an important tool for the search of improvement to the current fore-warming practice. By chance he heard about a gas-based fore-warming project outside HAL. After a discussion in the team, he wanted to find out more about it. He entered BPS and searched for information on Internet. The gas heating technology project was not as much an act of innovation, which to some degree it was, as one of learning a new technology through the support of BPS. Our informant acted as a corporate entrepreneur as he searched for opportunities suitable to improve productivity on his watch.

> *<u>Gas fore-warming of an aluminum producing cell.</u>*
>
> *An aluminum producing cell lasts about seven years. As it is replaced the new cell is being fore-warmed to around 920 degrees Celsius taking several days. This is done to prevent thermal shock when molten aluminum is being poured into it. The cell is normally fore-warmed only once in its life time. The electric up-start lasts approximately 48 hours while gas takes about 70 hours of fore-warming, making it slightly more expensive using gas. However, there are important benefits to gas. Electricity produces charcoal in the cell which is required by the employees to remove*

before starting production, making the gas alternative coming in normal production earlier. Gas fore-warming saves employees from working in high-temperature zones while making the cell ready for normal production. Furthermore, gas warming gives also environmental savings. Thus, in a life cycle calculation gas fore-warming comes better out economically.

After having collected information the team prepared its proposal before sending it to management. Being a very closed-knit group, the fore-warming team always discusses experience gained, or improvement suggestions, in plenum before a proposal is sent management.

"*When ideas are discussed in the group they most often turn out to be improved*". (Operator, Karmøy, 2005).

The ability to bring an articulated and codified experience to the attention of management, receiving feedback, and jointly agree on a course of action, was important for the fore-warming team. With the team's accumulated experience, together with information from other sources encoded into BPS, management quickly agreed to test out the gas fore-warming process.

Post script: gas forewarming project.

Management made a strategic decision that from 2004 all cells should be fore-warmed using gas. All cells starting up today are fore-warmed with gas.

(Operator, Karmøy, 2006).

We returned to Karmøy in the spring of 2005 to follow up our 2003 interviews. We remembered our informant from the fore-warming team. In the 2003 interview he made two comments on the negative aspect of BPS - finding "Karmøy operation" was difficult, and that documentation about one process was scattered. It turned out that during the summer of 2003 employees at PM Karmøy had become increasingly frustrated when using BPS. As employees were using the system it became clear that it was not as efficient as first believed. The problem was access to information. Not that SDOCS was any good, but BPS did not improve the ease of access. One of the more experienced employees told the Superuser that the design of the information structure, that is, the search for a routine, was wrong. The Superuser for PM Karmøy was a member of the production manager's staff. As protests came in a group of employees took the problem to the production manager.

The Superuser became a spokesperson for the operators, convincing the manager to stop further implementation of BPS until the problem was properly identified and corrected. While the design team had focused on the structure of the organization, production focuses on technology. Each smelting technology requires its unique operating routine, while same technology can be operated on using the same routine, with possible adjustments of local organizational structures. Thus, rather than designing the structure of the information along organizational lines, PM needed to structure it along both technological and organizational lines. According to the BPS Project Team the quality of the development product should be maximum 3-4 clicks to all relevant information. Unfortunately for the PM employees the consequence of this design was that all relevant information was located deep down in the system structure. Retrieval of information became burdensome with many more clicks than envisaged.

It took a new taskforce, with members of the different production sites, more than a year to arrive at the new and improved BPS structure for Primary Metals routines. Applying the revised version, an operator will now activate his stand-by window on the computer, choose a technology, then choose a geographic site, work process, and finally an activity - four steps. Furthermore, with this structure, all relevant information is "glued" together, either because they can be seen chronological, or because they are linked via web-technology. In our interview with the Superuser, Karmøy 2005, we were told that employees were satisfied with the new BPS when it came to searching for new information, and that the system supported the process of developing operating routines.

> "*(Today) BPS has many good qualities, and I believe it will make our job simpler as time goes on. … It is possible to learn from the documentation*" (Staff, super-user BPS, PM, Karmøy, 2005).

Due to a transparent organizational structure it is possible to achieve such changes as the employees in PM achieved. According to the Superuser, PM, Karmøy, they got accept for restructuring BPS, because "*it is not difficult to get acceptance for restructuring our practice. An operator can go directly to the production manager where he can put forward his proposal."* The employees feel empowered to participate in the changes of routines and technology when it is in the best interest of the company, according to the Superuser. The enhanced functionality of BPS was also verified by our informant at the fore-warming team.

"*BPS has been improved thanks to the restructuring of the technology focus. Karmøy pops up as a unit and one get more knowledgeable about own work area. (However) BPS is more like a network leaving little trace as to where you had been looking previously. … On the other hand the one-point lectures with pictures and video are very good. You could not have that in SDOCS*." (Operator, PM, Karmøy, 2005).

Returning to the fore-warming team, we learned in 2003 that they had cooperated with management to test out a new fore-warming technology. The project became more elaborated than first envisaged. First of all, a delegation from the team was sent to another company to study the new technology. But, as HAL's aluminum producing technology was different from the company visited, they did not get much support in form of solutions. Although the HAL team was told what was important when considering this technology, they had to figure out for themselves which technical components, and which changes to the operating routines, were required in order for the gas-fore-warming technique to function. Having successfully started up a test cell their success had much to do with the fact that they were experienced operators. They had no master standing next to them instructing them what to do. They had to learn as they moved forward with the project. The team learning was primarily cognitive, recycling accumulated experience and applying it to a new technology. And they succeeded, reducing the time of fore-warming a cell. On this basis they proposed a new routine in collaboration with management, and which received approval and implementation.

We wanted to know why the fore-warming team took the trouble to share experience and present proposals to management. After all, if some award was offered it was only a token amount and it was always shared among the team members. Although a driver, personal gain was a very minor driver. It was other issues that were more important. Safety, collegial cooperation and empowerment were other and more important issues. As the operator felt he was empowered to act, why should he not?

I share my experience when I see an operation, executed in a poor manner, may lead to a dangerous situation" (Operator, Karmøy, 2005).

The iterative dialogue between management and employees feeding experience back is important when a workforce is asked to participate in the organizational development. However, unlike our informant in the fore-warming team, some work leaders (lowest managerial level) do not consider such feedback relevant, or at least they do not recognize the

feedback as received from the sender. These operators are not encouraged by their managers to participate in the development of the production process. The fact that an employee sits down and log on to BPS, writes an experience and send it to a foreman, but get no response is a negative signal from management.

> *There are many employees who have used the BPS experience registration function, but they don't get any answer. Then it says itself that people stop bothering.* (Staff, Superuser, PM, Karmøy, 2005).

Primary Metal, Høyanger

Our first interview in Høyanger, June 2003, was carried out prior to their BPS implementation. This implementation was originally scheduled to take place in the winter of 2004. In Høyanger we wanted to capture the mood of using SDOCS in operation. Being a document handling system, applying a Lotus Notes technology, SDOCS was less flexible than BPS and applied a limited version of web technology. There were no difference between SDOCS and the printed version of a document stored in SDOCS. If you wanted to check out a routine in a document, containing many routines you still had to go to the content page of the document. Here you would find the chapter you wanted to go to, click on the search sensitive text to bring you to the front of the chapter. Once arriving at the first page you still had to sift through the pages until you got to your specific routine or page.

Those employees using SDOCS viewed it as a supplement to the printed ring-binder on the shelf, while others did not use the system. They went to the printed version on the shelf.

> *I don't believe I am using SDOCS at all.* (Operator, Høyanger, 2003).

These employees were capable of using computers. However, while computers were not in abundance, the primary reason for not applying computers when searching for routines was *accessibility* through the SDOCS structure. Documents in SDOCS were not easy to access, having to sift through pages and pages before arriving at the relevant section. It was much easier to pull out the ring-binder on the shelf and open it to the relevant routine. As they prepared for a maintenance operation, for example, the employees pulled out the ring-binder, open it on the relevant routine and went through it the day before the operation. They will leave it open til the next day and go through the routine again before starting on the job.

Another reason for not using SDOCS was *trust*. The operators did not trust the information found in the computer. There was no system of making sure that what was stored in the computer was actually the latest upgraded routine.

> *No, we hardly use SDOCS. Our primary source is the procedure in the printed ring-binder sitting on the shelf. … I trust the binder on the shelf more than what is in SDOCS.* (Operator, shift foreman, Høyanger, 2003).

While most of the operating employees used SDOCS only marginally, some of their colleagues did not use computers at all. The reason for this behavior can have to do with the type of work being performed.

> *We don't use computer. We use the telephone to contact a college if there is something we need to check*. (Operator, foreman, PM, Høyanger, 2005).

This informant, together with his team, works outdoor. *Access* to computers is difficult. Being out all day working on jobs such as cleaning a cell, a very hot and dirty job, one do not feel like logging on to a computer when encounter a problem. They use the telephone if running into difficulties. But access to computers for operators in general may be a problem in Høyanger. Operators had access to a computer in the lunch room, but as one informant told us:

> *Sitting in the lunchroom trying to concentrate on finding something you are not sure of how to do, puts a lot of stress on you. It is easy for the colleagues to make jokes about you, particular if you don't find what you are looking for.* (Operator, PM, Høyanger).

In addition to the computer in the lunch room, the operators also had access to a spare computer in the foreman's office. However, sitting and working on a computer in the foreman's office, while he is sitting there, was not a good experience either. Thus, lack of computer access was also voiced by our staff informant. Employees should be able to log onto a computer in more sheltered areas.

A fourth reason for not using SDOCS was the *general overview* of documentation. It was easy enough to find Høyanger, and also Primary Metal. But in a manual of 100+ pages, you may have to read through maybe 20 or 30 before you come to the relevant routine. This inflexibility was a very grave problem for SDOCS, which also restricted *navigation*. Reduced overview, restricted navigation and access, and lack of trust may be causes for preventing SDOCS from being used.

Yet, some of the employees in Høyanger found SDOCS easy to use and navigate in. In particular did staff with own offices and computer find SDOCS useful. Those who used SDOCS thought it had a better structure because it was organized along the organizational structure of the firm.

> *SDOCS is user-friendly because it is departmentally structured.* (Staff/Superuser, Høyanger, 2003).

Our Superuser informant also argued that SDOCS is always updated with the latest procedures. Operators' primary source of updating themselves on the routines should be SDOCS, and secondly the ring-binder on the shelf. Thus, the Superuser had a different picture of the use of SDOCS than his colleague operators. Another of our informants, a staff employee, was also satisfied with SDOCS. He had been part of the first design team developing SDOCS around 1995. He uses SDOCS particularly to check on operating procedures in regard to received improvement proposals on operation. Operating employees wanting to submit an improvement proposal dropped it into the company's suggestion box. The suggestion box is frequently used for employees wanting to make some extra money on their ideas. They will receive remuneration if the suggestion is found valuable. These suggestions can be related to operation or some other activities within the premises of HAL Høyanger. Positions below foreman are remunerable. Most employees, however, share experience without regard for personal gain, by bringing up a suggestion for change in the team meeting. Local improvements to production process or equipment are often achieved by employees sharing and discussing accumulated experience among themselves or their supervisors.

Sharing experience is common among operators in Høyanger. Most of the time operators share accumulated experience, for example in practicing a certain routine.

> "*Colleagues are good at sharing experience. Experience is things you have discovered while doing your job, and are talked about a good deal.*" (Operator, PM, Høyanger, 2003).
>
> "*Sharing experience is very much applied among the operators.*" (Staff, Superuser, PM, Høyanger, 2003).

An experience may be shared through general discussions within a team. However, should such experience lead to a change in operating routines, then the question of credit is brought up. One of our informants in Høyanger, an assistant shift foreman, pointed out that in his team

colleagues share readily experience and improvement proposals with each other. Not all experience is subject to remuneration, while any remuneration received goes to the group.

> *I feel that discussion around a problem within a work process is very good at the operator level. … We are not taking notes during the discussion, but ends up as a proposal after the discussion.* (Assistant shift foreman, PM, Høyanger, 2003).

Once the team has an idea of a proposal, they invite the Superuser to a meeting. At the meeting the team will share their experience on a given subject. The knowledge articulation and iteration process between a team and the Superuser in Høyanger can be as follows:

> *The team takes up a subject and I am invited to participate. I write out the proposal coming from the team proposing to change an operative routine. Afterwards I send the proposals to all the teams working in Høyanger. No routine is changed on only one team's suggestion. All members of the unit will be invited to comment, and any opposition must be based on facts. A deadline for comments will be given. Provided this is a local routine, and if no objection is being put forward, the proposal will be implemented in Høyanger's local BPS.* (Superuser, Staff, Høyanger, 2003).

A team which, after a proposal has been discussed with a Superuser, finds it interesting to send in a suggestion stands united behind it. Should this process lead to a change in the operation, no remuneration will be given. However, some of the employees may snatch the idea and send it in before the team has finished discussing it. Then such a person may end up with some remuneration.

> *If a colleague has a suggestion to a problem, but do not want to send it in, he will ask one of his team mates to send it in. There are a few employees who are very 'busy' sending in proposals, often without the consent of the problem solver or the team.* (Assistant shift foreman, Høyanger, 2003).

As a result of sharing remuneration, or in some instances having to forfeit it all together, some employees do not want to share their ideas. As the shift foreman suggested, some employees tries to benefit from the knowledge of others without giving something in return. However, they do not see it that way.

> *When we are entering the subject of experience from an operation, I ask what this experience has given me. Has it given me an idea to a better routine, etc.? Then I do not tell anyone right away, but evaluate the opportunity, because it now enters the area of reward. If the proposal has to do with a possible reward, I will not share it. Before I send in a proposal I need to write it down.. But first you need to gather more*

information about the proposal. You need to talk to other to find out if it is a good idea or not. Even if you air the idea with others in the group I make sure they do not understand the whole picture of my proposal before I have it registered in the suggestion box. You need to fish a bit, be a little bit sly. If not, you may stand to loos the idea. (Assistant work leader, PM, Høyanger, 2003).

There are other avenues for getting one's ideas operational as well. It is not uncommon in Høyanger that employees takes direct contact with production manager, whose responsibility it is to manage the PM's operation in Høyanger. Employees in Høyanger feel like communicating to those they consider relevant in order to get their views across. They definitely enjoy empowerment and use it.

My door is open for anyone who wants to tell me what we can do better, or what is wrong, and I answer all mails coming from my employees. We have an open system in Høyanger. (Production Manager, PM, Høyanger, 2003).

Once there is an agreement within the local management that a routine should be changed, the altered routine is entered into SDOCS by the Superuser. In addition, a routine is printed up and distributed to all the offices to be put into a ring-binder.

SDOCS is not used for organizational learning, or for transferring experience, in Høyanger. Organizational learning in Høyanger takes place through sharing between colleagues or through the ring-binder.

"*We do not use SDOCS to transfer experience; we use 'mouth-to-mouth' due to the large differences between the factories. … Besides, there is a barrier in that you need Lotus Notes, and the operators do not have access to such programs (you need a license)*". (Staff, Høyanger, 2003).

"*I have not seen anybody write in their experience in SDOCS, and I would not have done it myself*". (Operator/assistant foreman, PM, Høyanger, 2003).

"*Experience is not registered on SDOCS*". (Operator, Høyanger, 2003).

However, there are also conflicts when the issue of sharing experience is up. While operators sitting in the lunchroom may discuss this and that, they may be forced by some foremen not to discuss certain issues. It turns out that relationship between some foremen is not the best. Some foremen want others to look bad by refusing to tell about a certain problem, for example in the production hall. Another reason may be foremen who are ambitious and want

to look particular good. Such a foreman may present ideas which not necessarily is his, but may make him look good in the eyes of production manager.

> *Sharing experience is much more common among the operators than between the supervisors. However, there could be more sharing between the shifts. Her I see a competitive element between the foremen*. (Operator, assistant shift foreman, PM, Høyanger, 2003).

We returned to Høyanger in the spring of 2005 to follow up how the employees experienced the introduction of BPS. We wanted to find out if the employees used BPS more or less active than SDOCS, and what opinion they had about BPS. For example, in 2003 our staff informant wanted to keep SDOCS even though he had been informed about the pending implementation of BPS. He thought SDOCS' structure gave better value to the organization. The postponement of BPS in Karmøy impacted on the implementation in Høyanger. One of the employees which was invited to give his views on BPS was our staff informant. Having been a defender of SDOCS and an opponent to BPS, it would be logical that he also would be negative to the implementation of BPS in Høyanger. He was not; at least not negative to use it himself.

> *"As I started using BPS I understood it intuitively both system structure and the information stored in it.* (Staff, PM, Høyanger).

BPS had been introduced into the Høyanger operation by the time we arrived in the spring of 2005. BPS was now being used to learn experienced employees new routines. As the introduction of BPS now was a fact, all routines had to be restructured in order to support the process-oriented work activities. While adjustments had been made in relation to the production process of the aluminum production, the restructuring was in regard to areas of responsibility, cleaning up unnecessary procedural language, and establishing more succinct routines for easy overview and access to the meaning of a routine. What is also interesting is that Høyanger, dedicated to SDOCS in 2003, found that BPS was more apt to learn from. Although it is the production manager who is responsible for changing local routines, it is the Superuser who executes this responsibility. Such changes are based on received suggestions from the employees. Based on such feedback, production manager calls for a meeting to evaluate suggestions. Once a proposal is formulated it is sent on a hearing round to all employees.

> *Based on the meeting to change a routine, production manager is responsible for sending out the result and approving the final result. Everybody who is involved in the relevant work process is included in the change process.* (Staff, Superuser, PM, Høyanger, 2005).

All introductions of new routines in Høyanger, regardless if it is local or corporate, are the responsibility of Superuser. This is how he described the process:

> "*Implementation of new routines is my responsibility. I give a presentation and orientation on a shift meeting where I will use a PC and video canon. The operators can log into BPS and look at the new routine once the presentation is over. The presentation is an opportunity for the employees to check out if the new routines include own experience submitted by the operators.* (Staff, Superuser, PM, Høyanger, 2005).

With the introduction of BPS Høyanger is more actively using the system as a tool for organizational learning. It is being used for transfer of experience, for discussing between operators and management and for replicating new routines. Our staff informant made the following comment about use of BPS in implementation of a new routine:

> *All restructuring of work processes shall be announced through a presentation. This to make sure all employees gets the information one time. After that we are referring to BPS where they can find more information. For the presentation we are using (BPS) overhead and video canon to illustrate the sequence of work activities within the new work process routines. In order to succeed with changing the work practice among the employees you need to argue the case by illustrations in BPS. In the computer system you find the work processes (operating routine) supported by work flows and illustrations displayed on the overhead screen in the meeting room. From this overhead screen you learn new routines.* (Staff, PM, Høyanger, 2005).

It was now clear that employees were to use BPS to learn new routines. Illustrations 1.1 to 1.5 depicts the structure of BPS. The last illustration is a so called 'one-point' lecture. This is an illustration of how a result may look like. Many of the routines have an illustration, either still picture or video. This element has supported the learning process using BPS as representation of routines. According to our informants BPS structure has brought strength to the learning process in Høyanger. The employees do not view new routines as difficult to learn, nor do

they view themselves as newcomers. Employees in Høyanger are comfortable using BPS as a source of learning new routines.

> … *The new one-point presentation found on BPS has been a success. There are only positive feedbacks on the use of the new routines. The operators understand written presentations intuitively, provided it is comprehensible formulated. It is their experience as operators which make them understand new routines by being given an orientation before reading the details in BPS.* (Staff, Superuser, PM, Høyanger, 2005).
>
> … *One-point lectures turn out to be understood when the operators logs on to the PC and then click onto BPS.* (Staff, PM, Høyanger, 2005).

Being early days regarding the practicing of BPS, problems have risen. While not a big issue using SDOCS, employees have complained on the lack of available computers in quiet rooms. Another element which seems to have received some attention is the upgrading of routines stored in BPS. Employees have come across routines which clearly is no longer in use. Also lack of time to send in experience can be a point of contention. These may be issues which can reduce future productivity in Høyanger.

> *The problem for the operators with the application of BPS is access to a PC in a separate enclosure away from the lunch room and disposable time for using the computer. Also a lack of updated procedures can be dragging the system down. That is the direct reasons why employees do not use BPS for reporting experience. - they are capable of doing it, but lack access.* (Staff, PM, Høyanger, 2005).

Training new employees is a two-phase process. Firstly one gives them an orientation of the company, the production process and the relevant aspect of their future job. Then there is classroom training followed by testing what they have learned. This test is conducted by using BPS to locate the processes and activities they just have been taught.

> *We are testing the new recruits by asking them to enter BPS and control that what they have been taught is in line with documented practice. This is functioning very well, and BPS confirms that what they have learned is correct. (*Superuser, staff, PM, Høyanger, 2005.)

Metal Products - Marketing and Sales

MP-MS is a sales support unit located in the Karmøy site. With its main office in Karmøy and regional offices across Europe MP-MS is a geographically dispersed unit. Our first interview took place in January 2004, at the end of the implementation process in the unit. With a business process different from PM, MP-MS was not dependent on PM's redevelopment process of its BPS implementation, and could therefore start implementing its system. One of our informants is a Superuser and process leader in MP-MS. As Superuser she participated in the design of BPS. The design team has as its goal to "*make the work day simpler and gives a better overview of the work to be done for each employee."*

Prior to the implementation of BPS, MP-MS used SDOCS. We asked how easy it was to retrieve a routine from the old SDOCS relative to the new BPS. It was common opinions that SDOCS was difficult to both navigate in and retrieve documents from, compared to the new BPS.

> *SDOCS was drowning us in words. First we had to find the principle document, then we had to read pages up and pages down before we found the core section we wanted to check out.* (Staff, Superuser, MP-MS, Karmøy, 2004).

We returned in spring of 2005 for follow-up interviews with informants of MP-MS. We will in the rest of this story follow the use of BPS, and apply statements as it relates to work activities rather than in a chronological order. In 2005 we wanted to find out if the system still functioned. Furthermore, within this story two cases will be elaborated on. One case relates to establishing a new routine, the other relates to improving a current operating routine impacting a key performance indicator.

MP-MS has been able to apply BPS successfully to all facets of the learning process, making the MP-Sector an example of successful deliberate learning. MP-MS has been using BPS longer than other units in HAL. Being a service organization, one of the unit's tasks is securing detailed credit reviews for the sales force across Europe. To this routine MP-MS need to make sure all relevant documents are related to each other, so that credit is given under correct conditions. We asked which value BPS offered MP-MS employees.

> *When we are making a reference to some documentation in our job, BPS is irreplaceable. With its simple and holistic overview it is easy to understand the different processes stored in BPS.* (Staff, MP-MS, Karmøy, 2005).

Not only is the system supposed to support work processes, employees need also to understand the application of the system for it to be of any value to him or her. Application of the system is related to its ability to deliver value to the users. For employees in MP-MS to succeed with their jobs they are dependent on a system which both gives them an overview of the documentation as well as where in the process they are, at any point in time.

> *"The system is so visually very good that experienced people see right away how it is built up and is supposed to be used"* (Staff, Superuser, MP-MS, Karmøy, 2005).

During 2003/4 the employees were introduced to the new system through a series of meetings and computer-supported training. After a short introduction to the system, each employee was placed in front of a computer and was given access to a learning program. The purpose of the program was to test out employees' ability to execute normal activities carried out in the unit. This was achieved by asking the employees to execute such activities through the learning program. By circulating among the employees our informant could offer any additional guidance if needed. However, there was little requirement for such support.

> *When my people should learn to use the system, they got a little orientation and then started right on the computer without any other support. During an hour and a half they got hold of it.* (Staff, Superuser, MP-MS, Karmøy, 2005).

But it was not only the local Karmøy employees the Superuser was responsible for training in the use of BPS, all employees in the European offices had to learn the new system. This was a real challenge. She approached the challenge in different ways. At some of the workshop sessions she physically participated in a room using PowerPoint. Other sessions were through conference calls supported by intranet using PP. After instruction, each employee was going through a computer training program testing real-live examples of different types of routines. For the international workshops, she would monitor the result from the exercise on her PC.

> *I am responsible for implementing new routines within this unit. In that regard I am preparing a PP presentation. For implementation of the new BPS processes I had workshops with employees in both Karmøy and Köln where we went through my PP presentation in combination with a live BPS presentation and learning program. The presentation took an hour. Afterwards each employee was asked to start practicing BPS on a PC using the learning program. After an hour and a half they all became comfortable and knowledgeable in handling the new system. Learning all the processes will take longer time, however. But the task they were asked to solve during*

this lecture they all completed. For our colleagues in Spain and England we used net meetings, with same structure as the workshops. They were all comfortable with the system, finding processes and solving the task using BPS. Many of the participants in these training sessions were experienced employees. No one has uttered a word that they do not understand or have been made to look like a newcomer, a fact which speaks for itself when we saw the results from the training sessions. (Staff, Superuser, MP-MS, Karmøy, 2005).

But did the employees practice BPS once they had learned to use it? Some of the employees used BPS daily, while others used it a few times a week. All programs needed to execute certain jobs were linked to BPS. For example reports and other documentations were needed to execute a credit evaluation linked to the work processes and routines, and thus easy to access through BPS.

I have not received any feedback from colleagues not wanting to, or capable of, using BPS." (Staff, MP-MS, Karmøy, 2005).

Also training of new employees has been a success using the training structure for introducing BPS. From the German office two trainees were sent up to Karmøy to learn about HAL. Our Superuser informant was responsible for starting the two week orientation program. Although her job was to train them in the activities in Marketing and Sales, she introduces the trainees to HAL by going through HAL'S business process structured in BPS, identifying the total value chain. From her they were brought into the details of producing aluminum, all the way from upstream smelting to downstream customers, such as the car manufacturers in Germany. The second part of her task was to train them in handling MP-MS business. She used the same training process as with the experienced employees. The process went very well, and as they returned to Germany after the stay in Karmøy, they sent her a couple of suggestions for improving MP-MS' BPS. This told her that they had understood, not only the task of the job but the way to use BPS.

BPS is used for training new employees. By showing them the work process they get a picture in their head of how the process is functioning. As a training tool we have received strongly positive feedback. … New trainees came up from Germany. Half a day was used on training on BPS. As they returned to Germany two of them used BPS to send to me experience made from the system. … (Staff, Superuser, MP-MS, 2004).

We asked what MP-MS had achieved through the application of BPS. Figure 5.3 below illustrates the results of the subunit's learning loop found in HAL (see fig. 5.2), and is based on feedback from the unit's employees using BPS to share experience through articulation, codification and transfer. According to the informants, many have been transferring experience using BPS.

> *You can register experience in BPS. The experience is sent to me. I have received 15 proposals on improving the system and our work processes.* (Staff, Superuser, MP, Karmøy, 2005).

- Experience feedback
  - 15 feedbacks articulated, codified and sent to the Process Owner, of which
    - 11 related to improving Best Practice
    - 1 relates to developing a new process
    - 3 related to improving BPS
  - 5 came inn during September of 2005 and has not been acted upon
  - 9 action taken
  - 1 under consideration

Figure 5.3: MP-MS experience feedback

All feedback in figure 5.3 has been logged in Process Leader's computer. It is the articulated and codified result of employees' experiencing the use of routines in their work, and from those who have seen opportunities for processing changes to both operating routines and BPS. Transfer of coded experience, using BPS, has been executed by individual employees proposing the changes.

> *You can register experience that will reach the person responsible for the process. We are encouraged to send in proposals for improvements*. (Staff, MP, Karmøy, 2005).

According to our MP-MS informants the application of BPS has made their unit more *efficient* through developing new work processes, to be applied across the sector; and more *effective* by supporting employees in improving current processes impacting the strategic plan. Employees can bring an improvement proposal directly to Superuser/PL's attention.

Own experience is being articulated and codified onto a computer for direct transfer. The employee contacting Superuser/PL directly will also have a discussion, either through a computer or face to face.

> *In most cases employees developing an original proposal will normally do it through the computer for discussion. This is done without it being discussed with others in similar roles. We use mostly e-mail for such discussion. The direct dialogue is due to employees' geographic dispersion.* (Staff, Superuser, MP-MS, Karmøy, 2005).

Below we have described two cases from MP-MS: one relates to implementing a new routine, the other correcting a current routine linked to a KPI target.

A case of implementing a new routine

We will in this case follow the process as laid out in fig. 5.2. One example of increased *effectiveness* is a new process called "Scrap of metal". Due to some complex matter the scrap was handled different for every time the problem occurred, as well as for each employee handling this problem. This was not only a question of administrative differences, but also productive differences. In May, 2005 Process Leader, MP-MS, Karmøy, informed us about a process called "Sale of scrap metal". When going from SDOCS to the new BPS system a sales representative in MP pointing out that the routine "sale of scrap metal" was missing; in fact the whole routine consisted only of one sentence pointing out the responsibility to deal with scrap metal (phase 0 in fig. 5.2: external stimuli). After some consideration contemplating his action (phase 1), the operator sent PL a proposal for a routine text through the experience transfer function installed in BPS. This proposal was, after a dialogue (phase 2a), accepted by PL (codification takes place at 1b in the transfer process). The new routine was formalized and entered by PL into BPS under the relevant process (phase 3). The new routine, Sale of Scrap Metal, is being picked up from BPS by other sales reps and applied (phase 4).

> *The detailed description we received and installed in 2003 has turned out not to be complete. It must cover same activity across the whole sector.* (Staff, PL, MP-MS, Karmøy, 2005.)

In an e-mail we received in October 2005, this informant wrote:

> *We have to re-open 'scrap of metal' because it has turned out that the original routine does not cover the process satisfactorily as pointed out by other sales reps in e-mails to me.* (Staff, Superuser, MP-MS, Karmøy, 2005.)

Thus, the first encoded routine provided *raw material* for a round of improvements to the current routine. Rather than letting the routine become inactive, and the employees returning to practicing their old routines, the sales reps shared experience and thus supporting the development of more efficient routines. We thus have observed the following activities on a new knowledge evolution cycle: The sales reps applying the new routine (external stimuli) find it not satisfactory and starts formulating better proposals (phase 1). From her colleagues PL receives new proposals for improving the routine. Applying e-mail as medium, an iterative discussion between the users and PL takes place (phase 2). In a new e-mail sent to us 09.12.2005, she writes:

> *As process leader it is my responsibility to discuss the proposals with the respective contributors, coming from such dispersed locations as Madrid, Köln, Milan, Oslo and Karmøy, to be applicable across the Sector. The improved result must be accepted by all the operators before stored in BPS as a new routine.* (Staff, PL, MP-MS, Karmøy, 2005.)

At year-end 2005/06 the process of changing "sale of scrap metal" routine was in the middle of phase 2 in figure 5.2, of the second routine development round. Once a common understanding has been reached (end of phase 2), Superuser will codify the new version, distributing it to all involved for approval, before entering it in BPS (phase 3). Thus, in the first round it is the codified knowledge, prepared by the one sales rep which became the basis of OL and RD. However, in the second round it was PL who was responsible for articulating and codifying the routine based on input from all reps. Once the routine is stored as an improved process in BPS, all employees are being notified through an e-mail informing them of the new routine which they can access and apply in their operating activities (phase 4). The routine development process, starting out with accumulating experience from individuals across the organization, followed by knowledge articulation and codification is an employee-management iterated process nested in a multi-level organizational structure. The improved routine, diffused by PL and implemented by the employees, leads to increasing the firm's efficiency across the organization. This example illustrates first a double loop learning (new routine) applying a deliberate system, then there was a single loop learning (modification to the routine).

An example of correcting a strategic target

Another example is “Credit Overdue Days” (COD), an important process for registering unpaid bills within MP. COD has a Key Performance Indicator (KPI) attached to it, implying a strategic process. This current routine has been linked directly to a KPI established by management and can be controlled by both routine development and strategy correction.

A strategy related to COD can include HAL acting as a financial buffer for its customers depending on the current economic situation in a given market. An adjustment of the KPI is a result of a strategic correction or a correction of COD. A change in KPI will have a direct impact on the MP-Sector’s profitability, and thus a critical success factor for management. MP-MS is responsible for managing COD. Prior to BPS no link between this KPI and the routine handling the COD process was established within the organization. This could result in an overextending COD without it being registered as a deviation in KPI. Such missing link prevented experience from flowing through to management, making correction to the strategy. With the introduction of BPS it is now possible to link KPI to operating routines executing individual work processes, such as securing COD results. Through executing the COD process the employees are doing a constant surveillance on the market situation. Should for example economic conditions in the industry worsen, the COD routine will be changed leading to a change in the KPI, which again will result in a gap between KPI and strategy. On this basis, management is in a position to correct the strategic target.

Our findings suggest that routine development, applying a deliberate learning model, may achieve improved performance. As the KPI is a “meeting place” between management and employees, once management wants to adjust COD it can do so knowing that employees will in BPS find, understand and follow through the new routines. This way, both operators and management can influence the KPI, and thus, productivity. We consider changing KPI, in this case the COD routine, a double loop learning process. In both the Scrap Metal and COD cases a deliberate learning structure, illustrating a multilevel deliberate organizational learning process applying nested iteration, is securing dynamic capabilities for the organization.

5.3 Activities related to learning mechanisms

This section presents the results from the interviews as they relate to routine development. We have attempted to quantify the answers (Yin, 1994) given by the informants by aligning the tables 5.2 to 5.12 to the learning cycle identified in figure 5.2. We have listed the categories in the interview guide (Appendix C) to the three learning mechanisms. Table 5.1 illustrates the

structure of the tables, grouping the respondents into four groups of actors along two geographic locations. For each of the two computer systems there are three categories of tables corresponding to the three learning mechanisms: experience accumulation, knowledge articulation and knowledge codification. Each system, for each learning mechanism, is tabulated for 2003 and 2005. For each technology, i.e. SDOCS 2003 and 2005 - experience accumulation, we have made comments reflecting both the sentiments found in the three main stories as well as the tabulated answers. Although subjective, we have quantified the stories in order to arrive at some theory building propositions.

We applied the following interview categories for each of the three learning mechanisms:

- Experience accumulation (2003 and 2005 questionnaire)
    - Navigate: ease of mowing within the system
    - Find documents: identify relevant information with fewest possible clicks
    - Learn from system: structure information for comprehension and validity
    - Training new employees: new trainees, or employees not knowledgeable of sector
- Experience accumulation (2005 questionnaire only)
    - Old employees learning new routines: Employees knowledgeable of sector, being asked to implement new routines
- Knowledge articulation (2003/2005)
    - Sharing of experience: employees sharing experience with team/foreman/PO
    - Discussing the experience with colleague(s): employees bringing up own experience for discussion with team
    - Exercised a cognitive/behavioral activity
- Knowledge codification (2003/2005)
    - Arriving at a conclusion: employee articulate own/other's experience
    - Codifying the result: employee codifying own/other's experience onto a computer
    - Transfer of experience: employee sending own/other's experience to a receiver
    - Feedback of new routines to users from the Process Owner/Process Leader: PO/PL sending out new routines for implementation by employees

We will treat each learning mechanism as it relates to either the first interview (2003) or the second interview (2005). The four groups of actors subject to the analysis are: *PM*, *MP*, *Operation*, and *Staff*, can be analyzed by comparing: PM vs. MP, and Operation vs. Staff. In 2003 three of Karmøy's informants were working for PM, and one for MP. Of the three within PM, one was a practicing operator. The other two had been operators for many years but today considered staff being responsible for HES and PO/Training. For Høyanger all the employees' interviewed in 2003 belonged to PM. Two were members of the production teams while two were staff employees with years of operating experience.

Informants interviewed in 2005 had the following positions: For Karmøy there were two in PM and two in MP. There were three staff and one operator (PM). For Høyanger all three informants belonged to PM, of which two were staff and one was a team leader in production. The interview of team leader took place shortly after lunch. Before lunch he had completed a very "hands on" cleaning job removing old crust from a furnace. He smelled of tar and charcoal. All informants are experienced employees with at least 15 years experience in HAL. At the operational level we interviewed the following: in 2003 eight employees; in 2005 seven employees. Of the eight in 2003: four were interviewed for the second time.

Table 5.1: Structure for analysis

	Karmøy			Høyanger		
	2003/2005			2003/2005		
Org. learning elements / **Group of actors**	Experience Accumulation	Knowledge articulation	Knowledge codification	Experience Accumulation	Knowledge articulation	Knowledge codification
Primary Metal						
Metal Products						
Operators						
Staff						

Section 5.3 is organized by describing the answer given by each of the four groups in relation to the three categories of learning mechanisms. The informants' answers have been interpreted to mean one of three alternatives:

- Supportive (S): strongly favorable to somewhat/partly favorable
- Unsupportive (US): somewhat/partly unfavorable to strongly unfavorable
- No opinion (NO): Either had no answer to the issue or no strong feeling of either supportive or unsupportive viewpoints

5.3.1 Experience accumulation

In order for an employee to be able to retrieve a procedure from the computer for the purpose of learning, or reiteration of, a current routine, s/he has to be able to both navigate the computer system handling the routines, and finding the relevant data. During the development of BPS, the project manager solicited users' views on SDOCS. It was negative in relation to both the ability to navigate and find relevant data. For both the 2003 and 2005 interviews we found support for a negative view on the application of SDOCS.

Experience accumulation - SDOCS:

Table 5.2 gives the result of how HAL employees support the use of SDOCS in 2003, while table 5.3 gives the result of employee support in 2005.

Table 5.2: Experience Accumulation[1)] 2003 - SDOCS

	Karmøy [3)]			Høyanger [3)]			Total		Total answers
Measurement[2)]:	S	US	NO	S	US	NO	S	US	
Primary Metal • Karmøy: n=3x3=9 answers • Høyanger: n=4x3=12 answers		9		4	7	1	4	16	21
Metal Products • Karmøy: n=1x3= 3 answers • Høyanger: not applicable		3						3	3
Operators • Karmøy: n=1x3=3 answers • Høyanger: n=2X3=6 answers		3			5	1		8	9
Staff • Karmøy: n=3x3=9 answers • Høyanger: n=2x3=6 answers		9		4	2		4	11	15
Total		24		8	14	2	8	38	48

[1)] Based on following questions:
• Navigate
• Find document
• Learn from

[2)]Categories of measurements:
▪Supportive: S
▪UnSupportive: US
▪NoOppinion: NO

3) Karmøy: n= 4 informants x 2 groups X 3 questions = 24 answers
Høyanger: n= 4 informants x 2 groups X 3 questions = 24 answers

Table 5.3: Experience Accumulation[1)] 2005 - SDOCS

	Karmøy [3)]			Høyanger [3)]			Total		Total answers
Measurement[2)]:	S	US	NO	S	US	NO	S	US	
Primary Metal • Karmøy: n=2x2=4 answers • Høyanger: n=3x2=6 answers		4			4	2		8	10
Metal Products • Karmøy: n= 2x2=4 answers • Høyanger: not applicable		4						4	4
Operators • Karmøy: n=1x2=2 answers • Høyanger: n=1x2=2 answers		2				2		2	4
Staff • Karmøy: n=3x2=6 answers • Høyanger: n=2x2=4 answers		6			4			10	10
Total		16			8	4		24	28

[1)] Based on following questions:
• Navigate
• Find document

[2)]Categories of measurements:
▪Supportive: S
▪UnSupportive: US
▪NoOppinion: NO

3) Karmøy: n= 4 informants x 2 groups X 2 questions = 16 answers
Høyanger: n= 3 informants x 2 groups X 2 questions = 12 answers

Primary Metal: Most informants, both in Karmøy and Høyanger, were unsupportive of SDOCS' ability to support experience accumulation. Of the Høyanger PM who also belonged to Staff, they were in support of SDOCS. It is important to remember that while one Staff had the local responsibility of maintaining the system, the other had participated in its early development phase. Furthermore, as SDOCS was still the official system in Høyanger the two had a loyalty to its use. On the other hand, the operators spoke for many of their colleagues and had same opinion as the informants in Karmøy, that is, SDOCS is both difficult to access and cumbersome to identify relevant documents in. In 2005 the picture is getting clearer. Both data and the stories confirm that SDOCS has little support.

Metal Products: In our 2004 interview our PL informant was unsupportive of the SDOCS. At the time of the interview BPS had been approved by MP. Furthermore, we understand that MP was one of the driving forces for changing from SDOCS to BPS. We interviewed no informants from MP in Høyanger. Returning in 2005 no change in the attitude toward SDOCS had been taking place.

Operators: Looking at the operators' use of SDOCS none support its use. One voiced a "No Opinion". No change had taken place by the time of the 2005 interview. While no operators seemed interesting in using SDOCS, one did not use computers at all. As an outdoor worker he uses the phone if he runs into some operative problems.

Staff: In 2003 Høyanger's two staff representatives were somewhat ambivalent as to the usefulness of SDOCS. While they were mostly supportive of the SDOCS system, there were elements in BPS which they did not find in SDOCS such as an easy-to-navigate holistic overview.

> *"For SDOCS you first need to log on, and then navigate to the right document and then the right procedure. The time is running. It is much better to go to the document on the shelf"* (Staff, PM, Høyanger).

In 2005, however, we found no staff supporting SDOCS. For the two Staff in Høyanger, 2003, supporting SDOCS, it is possible that loyalty to the official position that BPS was the official system in 2005, may have colored their views. However, it is also likely that the changes made to BPS after 2003 may have meant the difference to the support of the system. In particular, the staff informants from Høyanger participated in altering the original BPS design in 2003.

Experience accumulation BPS:

Table 5.4 and 5.5 gives the result of the 2003 and 2005 interviews regarding employees' support of BPS. As has been pointed out above, the structure of PM's information in BPS was, through a petition to management, altered by the users to satisfy their requests.

Table 5.4: Experience Accumulation[1)] 2003 - BPS

	Karmøy [3)]			Høyanger [3)]			Total		Total answers
Measurement[2)]:	S	US	NO	S	US	NO	S	US	
Primary Metal • Karmøy: n=3x3=9 answers • Høyanger: n=4x3=12 answers	7	2		1	6	5	8	8	21
Metal Products • Karmøy: n=1x3= 3 answers • Høyanger: not applicable	3						3		3
Operators • Karmøy: n=1x3=3 answers • Høyanger: n=2X3=6 answers	1	2			1	5	1	3	9
Staff • Karmøy: n=3x3=9 answers • Høyanger: n=2x3=6 answers	9			1	5		10	5	15
Total	20	4		2	12	10	22	16	48

[1)] Based on following questions:
• Navigate
• Find document
• Learn from

[2)]Categories of measurements:
▪Supportive: S
▪UnSupportive: US
▪NoOppinion: NO

3) Karmøy: n= 4 informants x 2 groups X 3 questions = 24 answers
Høyanger: n= 4 informants x 2 groups X 3 questions = 24 answers

Table 5.5: Experience Accumulation [1)] 2005 - BPS

	Karmøy [3)]			Høyanger [3)]			Total		Total answers
Measurement[2)]:	S	US	NO	S	US	NO	S	US	
Primary Metal • Karmøy: n=3x3=9 answers • Høyanger: n=4x3=12 answers	5		1	6		3	11		15
Metal Products • Karmøy: n=1x3= 3 answers • Høyanger: not applicable	6						6		6
Operators • Karmøy: n=1x3=3 answers • Høyanger: n=2X3=6 answers	2		1			3	2		6
Staff • Karmøy: n=3x3=9 answers • Høyanger: n=2x3=6 answers	9			6			15		15
Total	22		2	12		6	34		42

[1)] Based on following questions:
• Navigate
• Find document
• Learn from

[2)]Categories of measurements:
▪Supportive: S
▪UnSupportive: US
▪NoOppinion: NO

3) Karmøy: n= 4 informants x 2 groups X 3 questions = 24 answers
Høyanger: n= 3 informants x 2 groups X 3 questions = 18 answers

Looking at the tables we can see a tendency in favor of employee support for BPS in 2003, ending up being strengthened in 2005. For the 2003 interviews the whole implementation process was postponed within PM and Høyanger still considered SDOCS as its official tool. This resulted in the PM sector being less clear on the supportive/unsupportive than MP. However, canceling out "No Opinion" there still is a majority of support for BPS in 2003 and 2005.

Primary Metal: While Karmøy is in favor of BPS in 2003, Høyanger is unsupportive. This is primarily due to the fact that SDOCS still is the official system in Høyanger. Returning to the sites in 2005, a change has been taking place. No major disagreement regarding BPS. This can also bee seen from the stories, where a tendency of approval in 2003 was strengthened in 2005. Once up and running the employees find BPS a supporter of experience accumulation.

Metal Products: Karmøy is supportive of the use of BPS in 2003. Our 2005 interviews confirm this tendency in support of BPS. Our story also confirms this view. Application of BPS in experience accumulation is an important part of the continuous development of good routines.

Operators: For 2003 the picture is less supportive in both Karmøy and Høyanger. One reason can be the poor structure of locating information pointed out by operators in both Karmøy and Høyanger. Another reason is probably the fact that BPS is still not the official system in Høyanger, and that Karmøy has put implementation on hold until problems are resolved.

However, BPS is being used by PM for some of the processes, such as HES. Returning to the sites in 2005, we still find some hesitation to the use of BPS. While there is no "Unsupportive" among the operators, there are still problems for the operators using a data system. The "No Opinion" indicates the low interest for using a computer system. This has been commented upon by one of the staff in Høyanger as lack of access to a PC and lack of time to use it.

Staff: In 2003 Karmøy has a clear majority in favor of BPS. Both PM and MP staff sees BPS as useful for their needs, while Høyanger is clearly against BPS. This BPS aversion may be a result of SDOCS' official position as well as system participation by the Høyanger staff in the design of SDOCS. In 2005 there is a change of attitude where we can see a clear indication of the acceptability of BPS. There is no "Unsupportive" or "No Opinion". This can be due to employees' participation in the BPS improvement process, and that loyalty to prevailing management decisions is strong. However, we found that the majority of the employees actually found BPS useful in relation to experience accumulation. This can also be read out of the stories. Her we find evidence that SDOCS was inferior to BPS.

Experience accumulation -training new and experienced employees

Two additional issues have been raised within the subject of experience accumulation - training new employees, and experienced employees learning new routines. We asked the informants about training new employees in 2003. The result can bee seen in table 5.6.

Table 5.6: Experience Accumulation [1)] 2003 – BPS/SDOCS

Training new employees

	Karmøy [3)] BPS			Høyanger [3)] SDOCS			Total		Total answers
Measurement[2)]:	S	US	NO	S	US	NO	S	US	
Primary Metal • Karmøy: n=3x3=9 answers • Høyanger: n=4x3=12 answers	3			1		3	4		7
Metal Products • Karmøy: n=1x3= 3 answers • Høyanger: not applicable	1						1		1
Operators • Karmøy: n=1x3=3 answers • Høyanger: n=2X3=6 answers	1					2	1		3
Staff • Karmøy: n=3x3=9 answers • Høyanger: n=2x3=6 answers	3			1		1	4		5
Total	8			2		6	10		16

[1)] Based on following questions:
• Training new employees

[2)]Categories of measurements:
▪Supportive: S
▪UnSupportive: US
▪NoOppinion: NO

3) Karmøy: n= 4 informants x 2 groups X 1 question = 8 answers
Høyanger: n= 4 informants x 2 groups X 1 question = 8 answers

As can be seen from table 5.6, while only one informant from Høyanger brought up the issue of using SDOCS as a method of training new employees, all four informants in Karmøy told us that BPS was very suitable for training new employees. There is a clear distinction between the enthusiasms Karmøy felt for BPS as a training tool compare to Høyanger's view on SDOCS as a training tool.

In 2005 we raised the issue of experienced employees learning new routines. The result from this question can be seen in table 5.7. In particular we wanted to find out if experienced employees could learn new routines from a computer/overhead screen. We wanted to know if experienced employees could learn from encoded knowledge or if they had to observe a "master" in a master-apprentice community-of-practice relationship to learn a new or improved routine (Cook & Yanow, 1993; Brown & Duguid, 1991). Table 5.7 gives a tabulation of the answers given by the informants. From the table we can see a clear indication that experienced employees can relate to new routines presented thorough artefactual means. None of the informants felt it difficult to understand information presented on a screen. All new or improved routines were presented that way. This confirms the stories told that, based on current knowledge within an area of competency, experienced employees are capable of recognizing new routines, learn from, and practicing, the new knowledge.

Table 5.7: Experience Accumulation [1)] 2005 – BPS
Experienced employees learning new routines

	Karmøy [3)]			Høyanger [3)]			Total		Total answers
Measurement[2)]:	S	US	NO	S	US	NO	S	US	
Primary Metal • Karmøy: n=3x3=9 answers • Høyanger: n=4x3=12 answers	2			3			5		5
Metal Products • Karmøy: n=1x3= 3 answers • Høyanger: not applicable	2						2		2
Operators • Karmøy: n=1x3=3 answers • Høyanger: n=2X3=6 answers	1			1			1		1
Staff • Karmøy: n=3x3=9 answers • Høyanger: n=2x3=6 answers	3			2			5		5
Total	8			6			14		14

[1)] Based on following questions:
• BPS supporting experienced employees to learn new routines?

[2)]Categories of measurements:
▪Supportive: S
▪UnSupportive: US
▪NoOppinion: NO

3) Karmøy: n= 4 informants x 2 groups X 1 question = 8 answers
Høyanger: n= 3 informants x 2 groups X 1 question = 6 answers

Summary - Experience accumulation

This section has analyzed how experience is being accumulated, applying two types of computer systems for knowledge representation, within each of the three subunits under consideration. According to the tabulated answers they confirm the stories told by the informants - we find no indication of SDOCS is being supportive of experience accumulation. Quite the contrary, many hope they will never have to use the system again. None of the comparison units stand out as in support of the old system. On the other hand, BPS was highly spoken of by many, something the tabulated answers support. Here are no abnormality or comparison units standing out. If anything, BPS has consolidated its position during the period. Applying BPS/SDOCS as tools for training new employees and learning experience employees new routines (tables 5.6 and 5.7), we find the same attitude as those displayed above. While SDOCS are thought of as a poor tool for training and learning new routines, BPS is considered a suitable tool for these functions and which can support organizational learning. Summarized, we see no difference between PM and MP, nor between Operators and Staff with regard to rejecting SDOCS. There is a clear indication toward a lack of SDOCS' ability to serve the organization's need regarding experience accumulation, a position which only was strengthened during the course of the study. Furthermore, we found support for use of BPS in accumulation of experience.

From these data we will argue that ICT-supported knowledge representation enhance learning. We will at the end of this chapter discuss the how and why it functions.

5.3.2 Knowledge articulation

This section will analyze how experience accumulation has led to articulation. We asked to what extent experience gained from applying current routines was being shared and discussed with colleagues. We found evidence, in both Karmøy and Høyanger, that experience gained from applying routines was being articulated both through socializing and control. Some employees discuss their experience with the team, some go to the foreman, and some apply own mental structure to identify the relevance of an experience before it is being written down and e-mailed a manager. Knowledge codification, such as sending an e-mail, is the result of an articulation process.

Table 5.8 tells us that employees share experience with each other on an oral basis. Thus, there is nothing in the data suggesting that employees are not willing to share their experience with someone, such as a good colleague, the team, manager, etc.

Table 5.8: Knowledge Articulation [1)] 2003 – Intermediary transfer

	Karmøy [3)]			Høyanger [3)]			Total		Total answers
Measurement[2)]:	S	US	NO	S	US	NO	S	US	
Primary Metal • Karmøy: n=3x1=3 answers • Høyanger: n=4x3=12 answers	3			4			7		7
Metal Products • Karmøy: n=1x1= 1 answers • Høyanger: not applicable	1						1		1
Operators • Karmøy: n=1x1=1 answers • Høyanger: n=2X1=2 answers	1			2			3		3
Staff • Karmøy: n=3x1=3 answers • Høyanger: n=2x1=2 answers	3			2			5		5
Total	8			8			16		16

[1)] Based on following question:
• Sharing w/team / supervisor

[2)]Categories of measurements:
- Supportive: S
- UnSupportive: US
- NoOppinion: NO

3) Karmøy: n= 4 informants x 2 groups X 1 question = 8 answers
Høyanger: n= 4 informants x 2 groups X 1 question = 8 answers

Table 5.9: Knowledge Articulation [1)] 2005 – Intermediary transfer

	Karmøy [3)]			Høyanger [3)]			Total		Total answers
Measurement[2)]:	S	US	NO	S	US	NO	S	US	
Primary Metal • Karmøy: n=2X1=2 answers • Høyanger: n= 3X1=3 answers	2			3			5		5
Metal Products • Karmøy: n=2X1=2 answers • Høyanger: not applicable	1		1				1		2
Operators • Karmøy: n=1x1=1 answers • Høyanger: n=1X1=1 answers	1			1			2		2
Staff • Karmøy: n=3x1=3 answers • Høyanger: n=2X1=2 answers	2		1	2			4		5
Total	6		2	6			12		14

[1)] Based on following question:
• Sharing w/team / supervisor

[2)]Categories of measurements:
- Supportive: S
- UnSupportive: US
- NoOppinion: NO

3) Karmøy: n= 4 informants x 2 groups X 1 questions = 8 answers
Høyanger: n= 3 informants x 2 groups X 1 questions = 6 answers

Comparing *Primary Metal* with *Metal Products* all seems to share experience between colleagues. Also among *Operators* and *Staff* the tendency to share experience between each other is the same.

We asked the same type of questions in 2005 to see if there were any changes to the basic concept of sharing. We wanted to be sure that people continue to look at sharing as valuable. From table 5.9 we see no significant difference from 2003. Both within *Primary Metal* and *Metal Products* experience is shared. Also within both the *Operator* and the *Staff* groups experience is shared. Thus, there seems to be no change in the attitude toward sharing experience during the study period. One reason for this can be that employees are of the opinion that experience shared among the employees may lead to improvement of activities.

From tables 5.8 and 5.9 we can assume there is willingness in HAL to share information. Furthermore we can conclude that such sharing takes place within geographical areas, and within teams and/or employee - supervisor. During the BPS development project, employees from all regions of Norway came together to share their experience between each other, and thus developed good functioning routines (Best Practice). Project management points out this sharing as an important success in exchanging experience across geographically locations. Yet, there are some sub-categories of sharing. For example, we learned that while operating employees share willingly, there are some foremen who seem to be of the opinion that sharing

is suspect. Also when it comes to good suggestions for the suggestion box, some employees may have more of a focus on him/her than on the team, even though it may have been the team who set the employee on “his idea”. However, barring these issues, we found that employees in HAL share from their experience.

Summary: Knowledge articulation

We choose to identify sharing information with colleagues, regardless of medium, as a manifestation of an articulation process. On this basis the employees at HAL seem as someone wanting to share their experience articulated through practicing the operating routines. Toward the end of this chapter we will be analyzing how and why this may happen.

5.3.3 Knowledge Codification

Having established the fact that experience is shared in HAL; that such experience is freely shared between colleagues; and, when colleagues from different regions come together, they also share experience freely. Then, according to Huber (1991), it is possible to also share such experience by articulating and codifying it through a computer. When individuals codify their understandings of the performance implications of internal routines in written tools, such as software, a high level of cognitive effort is required. However, also software’s ability to support such codification is important. Our issue is if such software can support employees’ willingness to codify accumulated experience into a computer.

Table 5.10: Knowledge Codification [1)] 2003 – direct transfer via SDOCS

	Karmøy [4)]			Høyanger [3)]			Total
Measurement[2)]:	S	US	NO	S	US	NO	US
Primary Metal • Karmøy: NA • Høyanger: n=4x3=12 answers					4		4
Metal Products • Karmøy: NA • Høyanger: not applicable							
Operators • Karmøy: NA • Høyanger: n=2X1=2 answers					2		2
Staff • Karmøy: NA • Høyanger: n=2x1=2 answers					2		2
Total					8		8

[1)] Based on following questions:
• Sharing experience via SDOCS

[2)]Categories of measurements:
▪Supportive: S
▪UnSupportive: US
▪NoOppinion: NO

3) Høyanger: n= 4 informants x 2 groups X 1 question = 8 answers

[4)] Karmøy was only asked about BPS in 2003

Table 5.11: Knowledge Codification [1)] 2003 – direct transfer via BPS

	Karmøy [3)]			Høyanger [4)]			Total		Total answers
Measurement[2)]:	S	US	NO	S	US	NO	S	US	
Primary Metal • Karmøy: n=3x1=3 answers • Høyanger: NA	2	1					2	1	3
Metal Products • Karmøy: n=1x1= 1 answers • Høyanger: NA	1						1		1
Operators • Karmøy: n=1x1=1 answers • Høyanger: NA	1						1		1
Staff • Karmøy: n=3x1=3 answers • Høyanger: NA	2	1					2	1	3
Total	6	2					6	2	8

[1)] Based on following questions:
• Sharing experience via BPS

[2)]Categories of measurements:
▪Supportive: S
▪UnSupportive: US
▪NoOppinion: NO

3) Karmøy: n= 4 informants x 2 groups X 1 question = 8 answers

[4)] Høyanger was only asked about SDOCS in 2003

Table 5.10 reports on the use of SDOCS in Høyanger to send an experience to a colleague or a superior. We found no support for this application on the part of SDOCS. Neither *Operators* nor *Staff* applied SDOCS for experience transfer. We asked the same question in Karmøy with regards to BPS. Did employees register their experience in BPS for the purpose of sharing? Table 5.11 identify that most of the informants, both in *Primary Metal* and *Metal Products*, as well among *Operators* and *Staff*, is knowledgeable about, and use, BPS as a tool for transferring experience to others.

While the majority of the informants registers experience in BPS, and has observed that other employees do so, one informant has yet to see this application used. His argument is that employees have still not received proper training in BPS at the time of the interview. Furthermore, after many of the employees within PM had received such training, the implementation was postponed due to inadequacy in the system structure.

In 2005 we again asked the question in relation to BPS. The results can bee seen in table 5.12.

Table 5.12: Knowledge Codification [1)] 2005 – direct transfer via BPS

	Karmøy [3)]			Høyanger [3)]			Total		Total answers
Measurement[2)]:	S	US	NO	S	US	NO	S	US	
Primary Metal • Karmøy: n=2X1=2 answers • Høyanger: n=4x3=12 answers	1	1		1	2		2	3	5
Metal Products • Karmøy: n= 2X1=2 answers • Høyanger: not applicable	2						2		2
Operators • Karmøy: n=1x1=1 answers • Høyanger: n=2X3=6 answers		1			1			2	2
Staff • Karmøy: n=3X1=3 answers • Høyanger: n=2x3=6 answers	3			1	1		4	1	5
Total	6	2		2	4		8	6	14

[1)] Based on following questions:
• Sharing experience via BPS?

[2)]Categories of measurements:
▪Supportive: S
▪UnSupportive: US
▪NoOppinion: NO

3) Karmøy: n= 4 informants x 2 groups X 1 questions = 8 answers
Høyanger: n= 3 informants x 2 groups X 1 questions = 6 answers

Comparing tables 5.11 with 5.12, there is no changes to Karmøy's results. However, since 2003, Høyanger has made BPS its official system. Her we can see that while no one in Høyanger used SDOCS to transfer experience, some have started to use BPS for this purpose. But, again, we can see that *operators* are more reluctant to use computers for sharing experience than *staff*.

Summary: Knowledge codification

For the purpose of our research question we needed to find out if employees not only wrote down an experience on a piece of paper, but in fact used the computer to codify and send. We started out in 2003 asking Karmøy if they codified share experience for transfer through BPS (table 5.11) and Høyanger if they transferred such experience through SDOCS (table 5.10). From the data we got a clear indication as to which system was capable of supporting of the employees and which system did not. Not only was BPS the preferred system in 2003, a clear

indication as to the popularity of using BPS was manifested in 2005 (table 5.12). Of course, there are some who will not use a computer regardless, or who "believe" in oral communication only, as we found in Høyanger.

5.4 Empowerment and design participation

Management has as its strategy to include all employees in the process of designing/improving routines through the application of ICT. Based on the foregoing analysis, we argued that it is possible for ICT-supported knowledge representation to enhance routine development through a deliberate organizational learning process. In addition to routine development, which was the central concept in this thesis, two other issues were explored within the context of this research:

- Employees as *participants* in developing a new technology system (BPS/SDOCS)
- Employees as *empowered* members in enhancing routine development

Employee participation

Some of the informants participated in the development of BPS, while others had participated in the SDOCS' original development team. Table 5.13 gives an overview of informants who participated, or did not participate, in the development team for BPS. We are asking if those participating in BPS development may have a different view on supporting BPS than those who did not. Table 5.13 reports that of 30 answers (15 respondents), 18 supported BPS (nine out of 15 respondents). 12 did not participate and did not support the system (six of the 15 respondents). Out of the six responding negative, two had participated in the design of SDOCS, and one stated he did not use computers when looking up information. The two participating in SDOCS were staff.

Table 5.13: Participating in development of BPS

	Karmøy						Høyanger						Total		
Year	2003			2005			2003			2005					TA
Measurement	S	US	NO	S	US	NO	S	US	NO	S	US	NO	S	US	
1. Participants more favorable to BPS than non-participants?															
Primary Metal															
Participant:	3			1			1			1			6		6
Non-participant:					1			3			2			6	6
Metal Product															
Participant:	1			2									3		3
Non-participant:															
Operators															
Participant:	1			1									2		2
Non-participant:								2			1			3	3
Staff															
Participant:	3			2			1			1			7		7
Non-participant:					1			1			1			3	3
Total:	8			6	2		2	6		2	4		18	12	30

Realizing that management allowed for a redesign to fit BPS to the need of PM (2. generation BPS), those who participating in the SDOCS design now changed their views on BPS. Both staff informants participated in the second generation BPS design. They changed their opinion of BPS from 'against' (table 5.13) till 'for' during the interview in 2005. Like the colleague in Karmøy, the Høyanger staff informant changed the view as a result of restructuring BPS, acknowledging that 2. generation BPS was more supportive than SDOCS towards the needs of the employees. This change of sentiment can be seen, among other, in table 5.5, where they agreed that BPS in many ways was of a richer quality (Daft & Lengel, 1986) than SDOCS. After an uttering of frustration with BPS in the second interview (2005), the Høyanger informant recognized that the change in BPS made SDOCS redundant. Furthermore, SDOCS turned out not to be what they had hoped for because "*the computer people took completely over the development of SDOCS, made it an expert system and stopped listen to us" Staff, Høyanger* (documents).

Employee empowerment

A strategic goal for HAL management is a dynamic organization. Its industrial focus is to improve productivity rather than expanding the total production footprint. To achieve such goal they empowered employees to improve or change operating processes and routines in a structured manner by participating in the development of routines. Furthermore, in

cooperation with local management, employees should be allowed to adjust best practice routines to local conditions. However, the CEO's adage still applied:

"*Every operation that can be done the same way shall be done the same way*".

CEO, HAL.

Table 5.14: Employee empowerment[1)]: 2005 only

	Karmøy [4)]			Høyanger [3)]			Total
Measurement[2)]:	S	US	NO	S	US	NO	S
Primary Metal • Karmøy: n=2x1 • Høyanger: n=3x1	2			3			5
Metal Products • Karmøy: n=2x1 • Høyanger: not applicable	2						2
Operators • Karmøy: n=1x1 • Høyanger: n=1x1	1			1			2
Staff • Karmøy: n=3x1 • Høyanger: n=2x1	3			2			5
Total: n=7x2x1	8			6			14

[1)] Based on following questions:
• What does it mean to you and,
•Do you feel you have it
We are here registering the answer to bullet point two above.

[2)]Categories of measurements:
▪Supportive: S
▪UnSupportive: US
▪NoOppinion: NO

3) Karmøy: n= 4 informants x 2 groups X 1 questions = 8 answers
Høyanger: n= 3 informants x 2 groups X 1 questions = 6 answers

All employees felt part of management's empowerment focus. Our findings suggest that on this point management seems to have achieved their goal. All of the informants identified empowerment as something they now possessed. That is, ability and power to participate in improving productivity through changing the way they work.

Summary: Report findings

So far in this chapter we have in our analysis matched the data to each of the learning mechanisms, and analyzed each subunit, representing two sectors, in relation to the old and the new ICT system, for both Karmøy and Høyanger. At the subunit level we have seen a pattern emerge. Having analyzed each learning mechanism in relation to each of the three subunits and its use of ICT, we have fulfilled part of the requirement for an embedded case design. However, if we only focuses on the analysis of subunit level without returning "to the larger unit of analysis" (Yin, 1994: 44), this becomes a subunit study. We therefore have to analyze the larger unit of analysis and its implication for Hydro Aluminium.

The purpose of the case study was to evaluate the use of ICT on routine development. In so doing we interviewed employees using such systems. Through the two sets of interviews, CSF (Fuglseth, 1990) and CIT (Flanagan, 1954), we have provided some evidence for maintaining that employees can apply computers for the purpose of experience accumulation, knowledge articulation and knowledge codification. Such a process, if encouraged by management, can lead to enhanced value creation. Deliberate learning in HAL is based on management's strategic intention to use BPS for such a purpose. The results from the interviews confirm that management has succeeded to some degree. The tendency for each of the mechanisms goes in favor of BPS as a tool for supporting routine development. Having, in our embedded study, analyzed two sectors and two sites, we feel reasonable certain that BPS will support the entire organization in Norway. Furthermore, having had a successful implementation in other European countries, such as MP-MS Germany, the system will support the larger unit of analysis. We will argue that figure 5.2 represents a "holistic" view of routine development using ICT as a supporting tool for a nested routine development process at the organizational level. In section 5.4 we have provided a holistic (Yin, 1994: 42) exemplar of why we will maintain that BPS do support routine development and enhance productivity at the level of the organization.

5.5 Analysis

In this chapter we have reported the findings from our longitudinal case study attempting to answer if, how and under which circumstances development of operating routines can be supported by ICT-represented knowledge. From the narrative of the interviews with our informants, supported by tabulation of these data, we can demonstrate that given certain circumstances, ICT-supported knowledge representation can enhance the development of operating routines. Employees, once encouraged to participate, are capable of using computers for organizational learning to gain new knowledge. This new knowledge is put into practice to accumulate new experience to be articulated, codified and institutionalized as new operating routines through an employee-management nested iterative feedback process. Our findings do not support the theory that organizational learning takes place through a master-apprentice relationship only. On the contrary, our findings indicate that organizations also learn through the application of computers. Thus, we can make the following statement:

> *(1) Our findings support our research question indicating that ICT-supported knowledge representation enhances routine development in business organizations.*

The conditions under which the learning activities take place are identified in our stories, and supported by tabulation of the data. Our data tell us that the foundation for an active employee participation to develop better routines is management's deliberate action to provide a holistic organizational learning mechanism. By looking at our data we find that HAL's old system - SDOCS, did not satisfy the requirements as identified in the knowledge management theory. For example, SDOCS was not holistic in the sense of a total overview of HAL's business process. Secondly, the system was sub-optimized by not offering an insight into a sector's work processes and thus did not offer an opportunity for operators to "see" upstream or downstream of their own work activities. This is important for process understanding - how your operative activities relates to the process before and after your job. Thirdly, a fully web solution was not technical feasible in SDOCS, forcing employees to sift through pages and pages of documents before arriving at the relevant routine. Fourthly, the system could not be linked to relevant internal and external data bases, thus hindering employees in getting other relevant information before making proposals for change. Fifthly, it had no feedback possibility to send employee-generated comments to the process owner. Finally, HAL's IT unit took away users' input from first design round by deciding to design it as they meant it to be in the second design round. Few employees actually used the SDOCS system. This can be seen from our stories and supported by tables 5.2, 5.3 and 5.10. However, these are qualities employees found present in the new system - BPS.

Furthermore, BPS is the result of a deliberate organizational learning process implemented by management for the purpose of inviting employees to participate in the development of operating routines through multilevel nested iteration. Our data, as tabulated in tables 5.5, 5.7, 5.11 and 5.12, demonstrate that BPS was actively used by employees in executing management's deliberate learning process. Our data indicates that these deliberate learning functions may have been contributing to the acceptance of BPS by the users.

Prior to the start of the BPS development process, HAL's management had decided to restructure the organization - from department to process orientation. They introduced value based management, focusing on common solution across HAL, integrated thinking, and organizational learning and development. Focusing on processes and process development as a strategy, management personnel needed a clear mandate on process responsibilities. Confusion could arise if for example an operating process was stretching over several of the previous functions organized in deep hierarchical departments. Included in these business

processes were descriptions of responsibilities for maintenance and development of rules, routines and work activities. BPS, developed along the process dimension, required a clear demarcation of responsibility. The most important issue was: whose responsibility should it be to manage and change routines related to a given sector, technology, work process, etc. Without a clear role of responsibility employees would not know who to send their accumulated experience to. On this basis management established the functions of Process Owner, Process Leader, and Superuser, within each of the sectors of the value chain. By this action management made it clear who the owners of the different business processes, and their operating routines, were and thus those ultimately responsible for a sector's part of the value chain.

> *(2) Our findings indicate that a computer-supported knowledge system, to be applied by employees for the purpose of participating in the development of institutionalized operating routines, requires:*
>
> > *(a) a management implemented deliberate organizational learning structure supported by*
> >
> > > *(a1) a set organizational learning mechanisms,*
> > >
> > > *(a2) a multilevel nested iterative employee-management feedback process,*
> >
> > *(b) identification of ownership roles for the purpose of attaching verifiable responsibility for individual operating routines,*
> >
> > *(c) content supporting a deliberate learning system.*

Systemic innovation explains why people may be positive to something they invented themselves, while they may oppose something new which they did not participate in developing.

The system development of SDOCS, like BPS, went through two design phases. SDOCS was a HAL IT-department's project. In the first development phase users participated in the design. However, it turned out that the system did not function as prescribed. But rather than inviting the same, or equivalent, employees back for a second design round, the IT department took over without any operating employee's participation. The IT department designed a system based on their conceived view of how document handling systems should function. Those informants participating in SDOCS' first design was initially negative toward BPS

(table. 5.12). However, as our informants became involved in the second BPS development phase they abandoned the support for SDOCS' – "they (IT) never got it right".

BPS was also a user-designed system, inviting users from all units in HAL to design and develop system and routines. Also BPS needed a second round of design before its functions were in place. However, rather than hand it over to the IT department, which was being considered, the process leaders in PM took over and invited operative representatives from all units to participate. Together with the project team the design group was able to develop a well-functioning system. Some of those employees negative to using BPS were invited to participate in the BPS' second design. They now became favorable to BPS. By the same token those participating in, and favorably to, SDOCS' first design, became unfavorable to SDOCS once participating in the second BPS design, may explain something about why BPS was preferred. Furthermore, many of the functionalities the users incorporated into SDOCS were not found after the second generation.

This user-participating design process made employees attach ownership to BPS. Table 5.12 confirm that employees participating in system design, either directly, or through representation, used such systems. Employees who did not participate directly in BPS design, but knew about colleagues representing their sector, also viewed BPS as belong to them. In the interviews this was implied by some of our informants. Thus, KMS, with its systemic innovation and media richness seems to be a strong concept for management to use in order to achieve employee participation in the application of computer systems.

> *(3a) Our findings confirm that employees participating directly in system designs are more likely to use, and enhance, the system and its content then if not involved;*
>
> *(3b) Furthermore, our findings identify that employees with indirect relation, through known colleagues, to the system are more likely to use, and enhance, the system and its content then if not involved.*

Management-introduced employee participation and empowerment in the development of HAL was stated in their strategy documentation (ref. ch. 1). Management's strategy was to include employees in improvement and innovation of HAL's business processes for the purpose of survival in a changing environment. By its deliberate strategy decision, management had prepared the ground for employee empowerment. Employees, by communicating their views to management in an iterative way, exercised their power to

participate in the development of routines (table 5.13). Furthermore, through the development of BPS the HAL management established organizational and technical structures supporting organizational learning, thereby combining computer systems with organizational learning. This act signalled to the employees a forward-looking, agile, employer who wanted to use employees' innovative capabilities for the development of HAL through BPS.

We consider the deliberate organizational learning process to be a contributing factor in employees' willingness to share accumulated experience. From our informants we were told that once an individual or team had forwarded some experience, the PL/Superuser would engage in a dialogue. This dialogue is important when a workforce is asked to participate in the development of routines. However, we have learned through our stories that some of the foremen do not share senior management's acclamation for employee participation. One informant told us that some of the foremen often did not bother to answer employees sending suggestions for improvement, resulting in a virtual stop of feedback from operators belonging to these managers. If this is spreading throughout the organization, employee participation will stop. Lower management may put in jeopardy a strategic intent having taken several years by senior management to implement should such attitude prevail in the organization.

> *(4a) Our findings suggest that empowerment is present among employees in HAL, that this empowerment is successfully being exercised by the employees, and that therefore management's strategy of employee involvement has succeeded.*
>
> *(4b) However, this research has also demonstrated that experience sharing is not a one-way street. A deliberate organizational learning void of multilevel nested iteration, where managers ignore the feedback loop, will not work.*

One area where empowerment and deliberate organizational learning seems to be present is in the area of experience sharing. We found that local sharing was in abundance. For example, one reason for sharing was to "*make our colleagues good"*. Another pointed out that he shared because he "*wanted his experience to be spreading"*. But most employees share in order to improve performance through the improvement of a process or technology. While employees have different reasons for sharing, none had personal gain as their primary reason. Most employees were unsupportive to sharing experience in order to make personal gain. However, there are caveats to this picture. For example one informant did not have an opinion as to the application of his experience outside own work place, suggesting that "*our experience can to a small degree be applied in other factories*". Another operator did not use

BPS to transfer his accumulated experience to the process leader because *"I am sure management knows this already"*. Operators tend to ignore the larger picture while offering their experience locally, thus engaging in myopic learning (Levinthal & March, 1993). However, while myopic learning may be a threat to this organization at some future, there is no indication that it is harming today's organizational learning process.

(5a) Our findings indicate empowerment as a contribution factor for a willingness by employees to share experience.

(5b) However, in view of respect for authority some employees may be prevented from fully utilize this capability leading to myopic learning.

Another potential failure by management is the reported lack of adequate computer facilities. As reported by some of our informants operators complained about lack of computer facilities located in quiet rooms. By not being able to sit in quiet rooms concentrating on the issue employees will not engage in learning mechanisms applying BPS. Again, a lower-level management's action being counterproductive to senior management's strategy may reduce the impact of BPS in the future. Within heavy industries attention to operators by providing adequate computer facilities can be viewed by some managers as extravagance. This view may originate in cultural differences. Going unchecked, however, managerial conflicts may hamper a future productivity gain. However, our data do not indicate that this potential conflict is impacting today's use of BPS.

(6) Our findings indicate a resistance by some managers to provide adequate ICT facilities for the purpose of sharing accumulated experience.

Another issue we wanted to explore was the questions if experienced employees are capable of learning new routines from data presented on a screen rather than being told by a master. Table 5.7 deals with this issue. All of the informants felt capable of learning new routines presented on a computer/overhead screen. Thus, we believe that experienced employees are *capable of learning* by being presented with codified knowledge represented on a PC or Over Head screen.

(7) Our findings indicate an ability by experienced employees to learn new routines through the application of ICT.

In conjunction with the learning question we asked if employees considered themselves *newcomers* since they had to learn new routines or new work processes (ref. Lave & Wenger,

1991). None of the informants, or colleagues of the informants, considered themselves a newcomer or an apprentice as a result of having to learn a new routine or a new work process. New routines do not seem to alienate employees and make them less valuable provided that the new knowledge is both logical structured and presented in a comprehensible way. Thus, within the area of this research's operational context, experienced employees will understand new processes and routines presented to them through an artefactual mechanism such as a computer.

(8) Our findings indicate that experienced employees do not consider themselves newcomers when a new routine is being learned, and should therefore not be treated as such.

Economic considerations

We have in this thesis discussed ICT's impact on organizational learning and routine development. This research has also uncovered episodes and incidents where it has been demonstrated that such organizational learning has led to economic improvements within the organization. Such improvements can bee seen from the stories told by our informants. Our findings support Brynjolfsson and Hitt's (1998) argument that employees make computers profitable.

Our interviews with management revealed productivity improvement as the goal for investing in organizational learning through BPS, and competent employees as the incentives through which such profitability could be achieved. Table 5.13 identifies employees' use of BPS, while tables 5.10 through 5.12 identify employees' codification of knowledge through BPS. Profitable stories represented in figure 5.3 identify some results from codifying new knowledge through BPS. The figure illustrates both improvements to the operation of MP-MS, such as improvement of Scrap Metal or Credit Overdue Days routines, and to the BPS functionality. In PM one example is the case of forewarming of cells through the infusion of gas developed by employees using BPS to find examples outside HAL, while another is the practice of placing two sacs of fluoride at the side of each furnace in stead of the traditional one sack. Fluoride is mixed by the operator into the molten alumina through an opening at the top of a furnace. At the side of each furnace a 40-kg sack is placed in readiness. Lack of fluoride in aluminum reduces the aluminum quality and subsequently profitability. The organization had experienced shortage of fluoride around the time shifts took place. This seemed to be a problem for many of HAL's operations. One operator suggested that when the

operator did his round placing a sack at each of the furnaces he should in stead place two making sure that the volume of fluoride lasted beyond one shift. This last routine was developed by one location and spread through HAL via BPS to be implemented by other units in the organization. Drop in aluminum quality can mean loss of high price per ton. Improved vigilance for the quality means higher price, and with costs remain constant or lower, profit will increase.

Having identified some exemplars of the results from using BPS we can surmise that it has been profitable for the organization and added competency to employees' knowledge frame. In all of the four cases above increased productivity has been achieved. Whenever an organization enhances its productivity through the use of technology added profitability will result. Such profitability can be the result of increased sale or reduced costs, or both. Hence, we will argue that the use of ICT will enhance a firm's profitability.

(9) ICT-supported deliberate organizational learning processes enhance a company's profitability.

5.6 Summary

Analyzing our findings we have been using the pattern-matching logic for our discussion. "This logic compares an empirical based pattern with a predicted one. If patterns coincide, the results can help a case study strengthen its internal validity" (Yin, 1994:106). We have in this chapter analyzed three embedded cases, PM Karmøy, PM Høyanger and MP-MS. All three cases demonstrate the application of ICT as a support for a deliberate method of routine development. All three embedded cases thus points toward the same result, a system seemingly functioning after its intention.

According to Huber (1991) more learning occurs when more varied interpretations are developed, when more members comprehend such varied interpretation, and when more members obtain this knowledge. This research has demonstrated, with the support of the result form the analysis of our data, ICT can function as shown in figure 5.2: a learning mechanism within an iterative nested multilevel deliberate organizational learning model. The deliberate organizational learning model supports the following routine development functions: experience accumulation, knowledge articulation and knowledge codification, for the purpose of diffusion and implementation of new routines. Included in this model are the elements of the learning mechanisms, moderating the process of routine development.

Thus, HAL seems to have developed an ICT system capable of executing its strategic intent of developing routines through deliberate organization learning. We have seen that BPS supports routine development, confirming our proposition that ICT-supported knowledge representation enhanced routine development through a deliberate organizational learning process. Furthermore, we have found that multilevel organizational learning takes place within a deliberate learning context, that this learning is cognitive/behaviour and negotiated through an iterative process between nested levels within the organization. That is, individual, group, and organization cooperate through a dialogue in the codification, diffusion and implementation of the new routines. Our findings also suggest that for employees to apply a deliberate learning structure it must be on their premises; they must be empowered to participate and contribute. A system void of employee participation, implemented unilateral, as was the case of SDOCS, is bound to fail. Empowerment is a strong support in pursuing the development of routines and processes, while designing the computer system strengthens employees' use of computers.

We have in this chapter found no evidence that SDOCS supported routine development. We have also demonstrated that the old system did not satisfy HAL's organizational learning requirements, suggesting that there are differences between the two ICT systems. We have, on the other hand, demonstrated that BPS functions in accordance with management's intended structure for an organization's learning process. Thus, it has been demonstrated that development of routines is taking place in the unit studied when applying BPS.

This study started out with the HAL organization as unit of analysis. It investigated multiple embedded sub-units before proceeding to bring the results back up to the level of organization, thus strengthening the confidence to the findings (Miles and Huberman, 1994). We will in the next chapter discuss these findings, and develop some propositions. In chapter seven we will identify the contributions made, limitations and practical implications, and suggest further research.

6 Discussion

This chapter integrates the findings from the analysis of the empirical data in the previous chapter with the theoretical perspective on organizational learning and development of routines. Thus, the purpose of this chapter is to advocate a modified perspective on organizational learning and routine development as it relates to the research question. The suggested perspective is arrived at on the basis of empirical findings from this research, and the theoretical perspective developed from prior research on organizational learning and routine development. In so doing we try to apply theory to empirical findings in order to understand why ICT, under certain conditions, can support organizational learning resulting in development of routines.

Each subunit within the case has been analyzed through stories and quantified for comparison. For each subunit, the purpose of the case study was to show how the learning mechanisms were enacted in the two ICT-systems for the purpose of routine development, and show how each unit acted as part of a larger organization even though they were local units (Yin, 1994). Management's deliberate intention to establish BPS should, in their mind, lead to a more active routine development process than the result achieved from SDOCS, and thus enhance productivity. Based on the tentative perspective (fig. 3.4), we have arrived at a theoretical perspective on routine development based on the theories applied in this thesis (fig. 6.1). Our theoretical basis is the cognitive/behavioral theory. However, management's strategic learning position has led us to incorporate a deliberate perspective on organizational learning, resulting in a dynamic process for routine development. Furthermore, an analysis of how employees engaged themselves in routine development with SDOCS and BPS, where BPS supported a management/employee deliberation process while SDOCS did not, led us to include a perspective on multilevel nested iteration. In view of our analysis, we will be applying our theoretical perspectives developed in chapter three and proposing expansions to applied theories. Furthermore, we wanted to find out under which circumstances routine development took place. To understand this we drew on the theories of empowerment and knowledge management.

Drawing on the findings in this thesis, we will in this chapter present a theoretical perspective on routine development and discuss applied theories in lieu of reported findings for the purpose of possible adjustment to theories. Furthermore, we will combine the theoretical

perspectives with our findings and, on this basis, arrive at an integrated deliberate learning model. It should now be possible to give some predication as to when an ICT system is likely to support the development of routines in large and dispersed production organizations. From this we will suggest some propositions.

The remaining part of this chapter is organized as follows: first a new perspective on routine development will be presented. Secondly, a deliberate organizational learning model (DOLM) will be presented followed by a discussion and formulation of our propositions, and, finally, we will conclude with a discussion of the findings presented in this chapter.

6.1 A new perspective on routine development

Detecting errors in a going concern is not likely to take place simultaneously among its members. Such detection will normally start with an individual employee acting on behalf of his colleagues "who deliberately seeks to improve performance and an intermediate process of deliberate thought and action through which improvement is achieved" (Argyris & Schön, 1996:4). Also, Huber (1991) starts the routine development process by identifying experience accumulated by individual employees. We will argue that this learning process, if made deliberate through the learning mechanisms, will meet "the conditions that warrant increasing efforts to turn implicit into explicit knowledge" (Zollo & Winter, 2002:344). Such learning will result in "an organization's improvement of its task performance over time" (Argyris and Schön, 1996:4). The improvement process, also referred to as "instrumental learning", can have two outcomes: "learning within a constant frame of reference or learning to change the value that define 'improvement'" (ibid, 1996:4). Changes within the constant frame can be changes made to a routine within the current operating strategy, while changes to the value definition can imply changes to the operating strategy. Argyris and Schön refer to these two types of change processes as "single- and double-loop learning" (1996:4). Without a deliberate learning mechanism, organizational leaning can, in our experience, at best be unsystematic and random.

In the literature review chapter perspectives on organizational learning was discussed, and from this discussion we arrived at the OL perspective, focusing on routine development based on the cognitive/behavioral theory (Huber, 1991; Argyris & Schön, 1996) to be the primary basis for our analysis. From this we identified the deliberate organizational learning perspective (Zollo and Winter, 2002) and the multilevel organizational learning process

(Crossan et al, 1999). From Huber, we have also seen that organizational leaning can be supported by structured memory system, such as computers, and that organizational learning takes place at all levels of the organization. From Crossan et al., we have learned that organizational learning is an integrating-interpreting feedback loop process (1999:525) in a multilevel relationship between individuals and group. This is important to understand for the success of a dynamic routine development process, as a top-down management approach will stifle the dialogue such a process is so dependent upon (Thorsrud & Emery, 1969). Our data indicates that such dialogue is both iterative and nested and can take place supported by the structure of ICT. This implies a closer and more engaging process between the levels of an organization than that indicated by Crossan et al. We have observed that the process related to both knowledge articulation and codification is iterative and where individual/groups at different organizational levels feed on each others' knowledge. Furthermore, the organizational levels are deliberately nested for the purpose of continuous improvement of routines through organizational learning. Such iteration takes place also through ICT. The deliberately nested structure is a result of a corporate strategy where the organization has been empowered to secure better routines. On this basis we have arrived at a theoretical perspective of routine development as can be seen in figure 6.1. On the basis of figure 6.1 we will confirm the tentative perspective on routine development seen in figure 3.4.

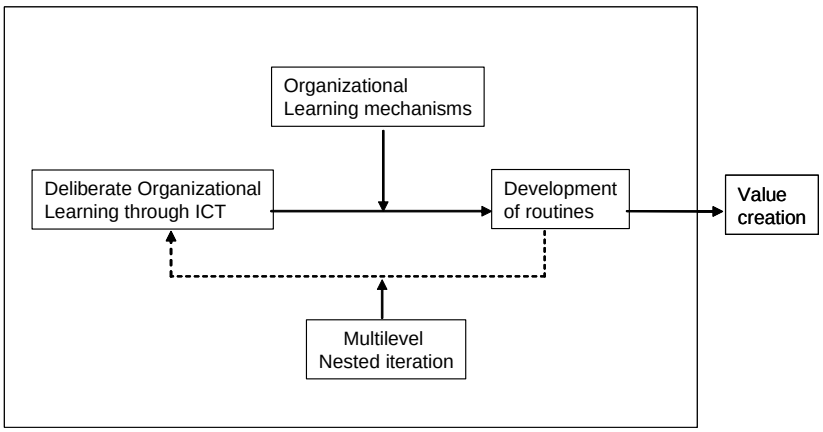


Fig. 6.1. A theoretical perspective on routine development.

Figure 6.1 is presented as a theoretical perspective of routine development by applying our findings to our theory building in chapter three. Based on our discussion above, we identify the independent variable "deliberate organizational learning" as consisting of three elements: (1) a deliberate management strategy for securing employee participation, (2) an organizational structure effectuating routine development, and (3) an ICT-supporting

knowledge representation system securing experience transfer, nested iteration and institutionalized routine diffusion. In so doing, we argue that it is not enough merely to have a computer system, such as SDOCS, as this clearly does not support management's strategy. We are also expanding the concept of Zollo and Winter's (2002) routine development process. They pointed out that experience accumulation was articulated and codified through mechanisms, such as collective discussions and writing manuals, and use of "the managerial attention to be invested in the development and updating of the task-specific tools … it was the team who decided whether and how to update it, and then do it" (2002:343/345). We are enlarging the deliberate learning process to include both nested iteration and ICT as a tool for supporting the explicit learning process. This learning process requires that an organizational structure manages the explicit learning process, makes sure management and teams are unified in which experience to protect in form of new routines, and which to exclude, and thus avoid negative types of learning (Levitt & March, 1988:78). Not all experience is suitable for organizational learning, or acceptable as a local practice, hence the iteration.

Furthermore, we have enlarged the feedback loop in our tentative perspective with "multilevel", making the feedback loop a reflection of a nested link between organizational levels where an iteration between these levels take place. According to Zollo and Winter (2002), dynamic capability is a firm's ability to systematically generate and modify its operating routines in pursuit of improved effectiveness (2002:340). The combination of deliberate organizational learning and multilevel nested iteration is a systematic process of generating and modifying a firm's operating routines creating dynamic capabilities. Finally, we maintain the moderating variable 'organizational learning mechanisms' from our tentative perspective, reflecting Zollo and Winter's (2002) view that the mechanisms are the basis for achieving changes to operating routines.

Our case has demonstrated that employees engage the learning mechanisms when externalizing accumulated experience. Furthermore, we have demonstrated that a deliberate introduction of a routine for the development of operative routines enhances organizational learning. However, while Zollo and Winter (2002) identified these two elements in their theory, they relied on natural evolution as the process of arriving at the most suitable routine from accumulated experience. Our findings demonstrate, on the contrary, that this process can be executed through a multilevel nested iteration, making it more effective. Employees will also take ownership of new processes by exercising management's empowerment intent

through participating in the organization's routine development, and thus securing a well-functioning organizational learning and execution process. We are therefore arguing for an *expansion* of Zollo and Winter's (2002) *theory by institutionalizing an ICT-supported multilevel nested iteration and empowerment* in combination with their deliberate organizational learning process.

Crossan et al (1999) provide a theoretical basis for organizational learning through a multilevel process starting with the individual. By identifying interpreted experience as the basis for integration at the group level, and finally institutionalizing this experience at the organizational level, the organization goes through a process of learning. Thus, this theory confirms the possibility that an organization can learn through accumulation of experience by individuals and passing it on to next level, and so on, and as such supports our findings. However, our findings go further. We found that it is not enough to share accumulated experience. For the employees in our stories who did not receive a confirmation of their articulated knowledge, the process came to a halt. In order for the organization to learn through deliberate organizational learning an empowered work force, operating in an employee-management iterative process modus, needs to be in place. This is what our case has demonstrated. We would like to enlarge Crossan et al (1999) theory by including *an empowered workforce operating in an employee-management iterative process* modus before new routines are being institutionalized, thus making their theory more robust.

Knowledge management theory is by Easterby-Smith and Lyles (2003) presented as a practical cognitive theory. Others have identified it as having weak explanatory power. In order to strengthen the explanatory power of knowledge management, therefore, we propose to incorporate both systemic innovation and media richness into the KM theory. We found that under certain circumstances the use of ICT as a knowledge-representing artefact enhanced the development of operating routines and thus productivity. This makes it possible to argue that a KM system can enhance the development of operating routines. We have observed that those participating in the design of BPS were more favourable to that system than those having participated in the design of SDOCS. Furthermore, we found that those employees who were negative to BPS became positive to it once involved in redesigning the new system. A further finding we made during the analysis was peer acceptance of indirect participation in the design of a computer system. That is, colleagues who know that one of "us" has participated in the design of a system in use makes them attach ownership to the

system. Thus, we can confirm the systemic innovation theory of enhancing the application of ICT in the routine development process through the participation of operative employees in the design of computer systems. Therefore, *we would like to add to the systemic innovation theory by including indirect participation resulting from colleagues knowing someone who has participated in the system design process.*

Organizational learning and routine development are context specific. Furthermore, industrial knowledge is idiosyncratic. The more one work within an industry the more one learn about its particular knowledge structure. This is then reflected as cognitive maps within the head of individual employees (Walsh, 1995). Transforming this knowledge into operating routines and place it in an appropriate structure within the KM system secures the stored information as clear and unambiguous, enriching represented knowledge on the operator. From this we will argue that by enlarging KM theory to include the above two theoretical elements - system innovation and media richness, we strengthen KM theory's explanatory power.

According to our findings (as shown in table 5.7) the informants maintained their ability to understand the implication of a new routine seen on a computer or an overhead screen for the first time. They told us that they were able to understand because they had prior knowledge which they could associate with. New information coming in to an organization, a group or each employee, is absorbed, assimilated and applied to commercial ends relative to the prior knowledge base (Cohen & Levinthal, 1990). However, according to Brown and Duguid (1991) new operative knowledge, to be learned by experienced operators, is best learned through a master-apprentice process within a community-of-practice. Our findings suggest a difference in employee attitude between the old and the new ICT system. While SDOCS was used only marginally, and some even undermined it by not using it at all, BPS is used by most of the informants. On this basis we argue that when employees' ability and dedication to learn new routines are present, they will most likely be able to learn new routines stored in the organizational memory for the purpose of implement those routines. Thus, we would like to enlarge Brown and Duguid's (1991) theory by including that *within industrial settings experienced employees are able to learn through ICT-supported knowledge representation*.

In conjunction with the learning question, we asked if employees considered themselves *newcomers* since they had to learn new routines or new work processes (ref. Lave & Wenger, 1991). None of the informants, or colleagues of the informants, considered themselves a

newcomer or an apprentice as a result of having to learn a new routine or a new work process. New routines do not seem to alienate employees and make them less valuable, provided that the new knowledge is both logically structured and presented in a comprehensible way. Thus, within the area of this research's operational context, experienced employees will understand new processes and routines presented to them through an artefactual mechanism such as a computer. Thus, we would like to expand Lave and Wenger's (1991) theory by including that, *within industrial settings, experienced employees do not consider themselves newcomers when a new routine is being presented and learned.*

With regard to the theories discussed above, none of them have reported that they have tested the application of ICT in the process of organizational learning within an industrial setting. The theoretical perspective is now reflective of our data. In the next section we will develop an integrated deliberate organizational learning model based on the theoretical perspective represented in figure 6.1.

6.2 An integrated deliberate organizational learning model

Organizations whose employees have accepted management's strategy for change practice will most likely obtain higher return from establishing a deliberate learning process. This is because such organizations are more effective in shifting behaviour to exploit the novel understanding originating from an explicit learning process (Zollo & Winter, 2002:346). Based on the new theoretical perspective, we have developed a deliberate organizational learning model (DOLM) that we believe represents the routine development process taking place in HAL.

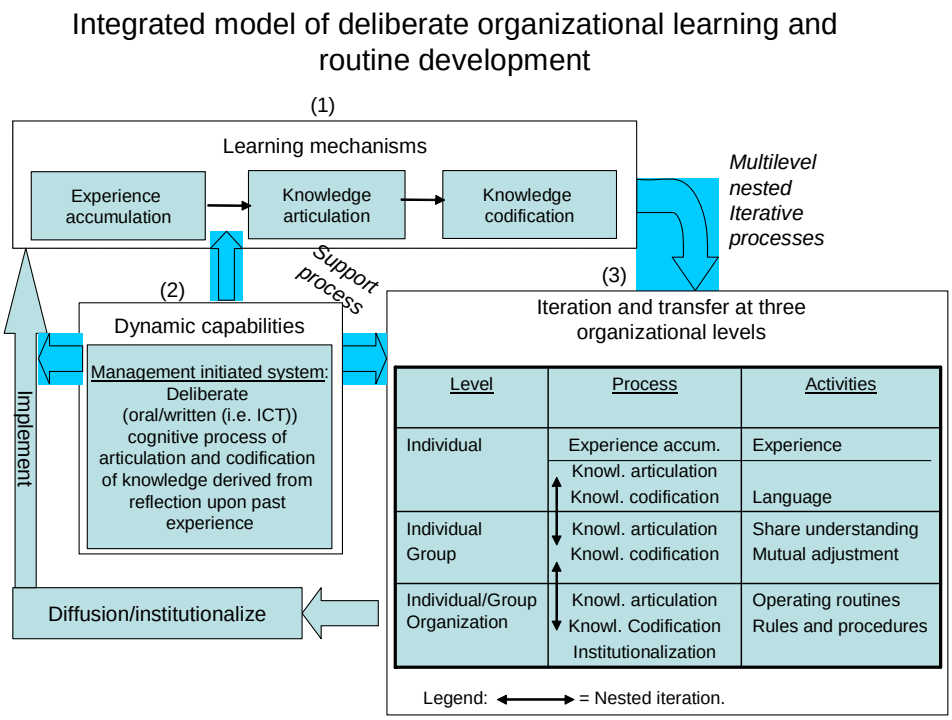


Figure 6.2. Integrated model of deliberate organizational learning and routine development.

Figure 6.2 contain three basic modules: (1) learning mechanisms, (2) a deliberate learning module, and (3) a multilevel nested iteration module. The model is reflecting the points made in section 6.1. Modules one and three represent the organizational processes, while module two is support processes. This module contains (1) management's strategic purpose, (2) the organizational routine established to enhance routine development, and, for this research, (3) an ICT system capable of supporting the deliberate intention of management. The managerial intention is to structure routine development within the organization. Our data support the possibility for ICT to be incorporated in the deliberate organizational learning model, where ICT provides a supporting structure for the model. Furthermore, our data demonstrate the presence of a multilevel nested learning process, where an integrated dialogue takes place through iteration between organizational levels. We have identified the iterative process in the model taking place in module 3 in figure 6.2. The module illustrates that knowledge articulation and knowledge codification are taking place throughout the organizational levels, as identified in our research and reflected in the theoretical perspective (fig. 6.1). Iteration is signified through the double arrows signaling a cooperative, rather than a competitive, process between levels.

In our first embedded case, PM Karmøy, we discovered that employees used BPS for retrieval of routines, transferring experience, and for developing new routines, such as the gas fore-

warming process. This process was strengthened by the second set of Karmøy interviews. Our second case, PM Høyanger, on the other hand, applied SDOCS during the first interview series, but only partly, and for routine retrieval only. However, during the second interview we found that employees' application of BPS was stronger than the use of SDOCS during first interview. Furthermore, the informants admitted that BPS was a better system then SDOCS. Some of the employees had also participated in SDOCS' design at the early part of its development. Our third case, MP-MS Karmøy, used all of BPS' functions, including developing new routines to impact the strategy of the firm, such as changing the KPI values. All three cases demonstrate the application of ICT as a support-tool for learning mechanisms, organizational learning, and diffusion/implementation processes in the pursuit of routine development. In a follow-up user-application survey done by management, it turned out that employees were satisfied with the BPS implementation and learning process conducted by the implementation team (document). Furthermore, e-mails received from the Project Manager indicated that employees were satisfied with the functioning of BPS once it had been modified. All three embedded cases thus points toward the same result, a system functioning after its intention, while SDOCS failed to fulfill its intentions.

SDOCS failed, according to our informants, because it was designed by IT experts rather than the users. Being overlooked by the IT department during SDOCS' design phase "employees using the new system is little motivated in using it if they are not allowed to influence the design of it" (Grønhaug & Kolltveit, 2005:57). In the second generation SDOCS the IT department had, without consulting with the users, removed functions suggested by the users during the first design. Furthermore, SDOCS failed to provide functionalities beyond being a document handling system. For example, employees could not send accumulated experience from a routine being practiced and the system did not allow for a holistic overview from where one could navigate to different functions; nor did it support a work process oriented structure. The absence of these functions may have prevented employees from wanting to use SDOCS. Also, the lack of a web-application making it awkward to find relevant documents stopped employees from using it. It was easier and quicker to use the ring-binder on the shelf. You could open it up, leave it there fore the next day and get on with the job. Hence, employees did not find SDOCS useful.

BPS, on the other hand, was designed by the employees, was easy to use, was productive in its search and had functionalities appealing to an employee having been given the opportunity

to participating in the development of operating routines. Being empowered to participate in the development of routines and the computer system employees are given strong incentives for the application of BPS. From our informants we also learned that a holistic overview is important for them to know where they are in the system. This ability secures an effective search for relevant documents, thus preventing the employees from wasting time. Being able to download additional information related to your routine is another functionality supporting the use of BPS. Rather than going to the ring-binder, the operator can now go to the PC and not only download a copy of the routine, which he will find in the ring-binder, but also check if there are adjustments to the routines, or linked information relevant for the operation.

Our research has been based on the cognitive/behavioral learning theory, arguing that employees can learn through a cognitive/behavioral pattern. Tables 5.2 through 5.12 demonstrate that employees can learn through the application of computers. Furthermore, provided that DOLM represents a deliberate strategy decision by management, that their intention is to apply an ICT-supported deliberate organizational learning process useful for the employees, and that its design has been supported by the users, then the employees will use DOLM for development of operating processes and routines. The results from the findings suggest that knowledge represented through ICT supports organizational learning and enhances routine development and productivity in business organizations. Applying our data to our theoretical basis we will formulate a set of propositions. Thus, our first proposition can be formulated:

> ***P1a: ICT-supported knowledge representation, if intrinsic in an integrated deliberate organizational learning model, is likely to enhance development of routines in business organizations.***

A routine development process can result in effecting both strategic and operative routines. Under normal business situation changes made to routines can result in correcting a strategic target or changing a current operational process. Our data confirm that routines developed by employees, through the support of ICT, can affect both a current operation, by adjusting its routines, or current key performance indicators, through adjusting strategic goals (Argyris and Schön, 1996). We have in this research seen that BPS has supported both single loop and double loop organizational learning processes. From this we can draw the following proposition:

P1b: When a deliberate organizational learning model is being applied by employees it is likely such application will result in single loop and double loop learning processes.

Furthermore, we learned in chapter six that BPS has supported routine development improving HAL's productivity. While some of the provided exemplars can be related to a single loop, others, such as the overdue account and the use of gas forewarming, can be argued as double loop learning processes. Thus, it must be assumed that whenever the organization engages in a process of changing, or implementing a new, operating routine it is for the purpose of enhancing value creation. On this basis we can make the following proposition:

P1c: When an ICT-supported deliberate organizational learning system is established for the purpose of developing operating routines and processes it will most likely enhance value creation in business organizations.

6.2.1 How ICT can support routine development

We have, from our analysis, learned that for a system to support routine development it must be functional, and employees must be familiar with the structure in order to be able to use it effectively. Unfortunately for most operating employees a new computer system may be neither functional nor familiar (in this section we include familiarity in functionality). However, through participating in its development one can be familiar with the functions of a system. In this sense, functionality is meant to be a positive or negative motivating factor for using the system. The involved employees are motivated to a greater or lesser degree of activity in using the system depending on an employee's participation in influencing the design of system and/or content. Thus, by applying the theory of systemic innovation and media richness to knowledge management we are finding support of KM theory in our data.

Systemic innovation explains why people may be positive to something they invented themselves, while they may oppose something new which they did not participate in developing. In this research we have learned of two ICT-systems being developed in-house and practiced among employees. One system was, in its final version, designed by the IT department based on their conceived view of how document handling systems should function. The other system was, in its final version, designed by the support of representatives from the user community. While SDOCS was rejected by the uses BPS was accepted.

Media richness explains why some information is clear and unequivocal, while other information can be unclear and equivocal. Comprehending knowledge stored in a KMS will depend on how information is being stored, what is stored, and within which context it is stored. Clarity and unequivocally is related to an organization's information processing, the behaviour of employees and management, and how the information is being applied in relation to its level of performance (Daft & Lengel, 1986). Linked to a KMS it will be advantageous for the organization's information processing that those who knows are the ones which supply content to the system. Furthermore, KMS has demonstrated its effectiveness by linking relevant information presented in an understandable process oriented fashion and offering feedback loops for experience accumulation. These functions can be found in BPS while they are absent in SDOCS. Thus, we argue that the KM theory of holistic and encompassing information structure is supported by our findings.

We have learned that some of the participants in designing the first system were negative to the introduction of the second system, while those participating in the second system were positive to its introduction, as well as its reintroduction after the second design round. However, those negative to the introduction of the second system were invited to participate in its second design round and subsequently became convinced that this was the best system. Furthermore, our informants reported that colleagues not participating in BPS design were using the system because they knew someone who had participated. This user-participating process of system and/or content design, including both those directly engaged as well as those "indirectly" engaged, made employees attach ownership to the system, and found information meaningful. Based on these data we can draw the following proposition:

> ***P2a: When employees are included in a system and/or content design process it is more likely that they will apply, and enhance, information represented in the system then if not included in its design.***
>
> ***P2b: When employees know of some colleagues having participated in a system and/or content design it is more likely that they will apply, and enhance, information represented in the system then if such acquaintanceship do not exist.***

6.2.2 When ICT can enhance routine development

Thorsrud and Emery's (1969) findings suggest that an employee's positive attitude toward the application of an operating process relates to this employee's control over their own activities.

This will materialize through personal initiative and creativity (Thorsrud & Emery. 1969:13). The authors place 'empowerment' within a socio-technical theory, where management switches its managerial focus from internal control over each unit to control of relationships between units and tasks, leading to focus on tasks rather than persons, and places responsibility where it is most effective (1969:180-184).

Management-introduced empowerment was stated in HAL's strategy documentation (ref. ch. 1). Management's strategy was to include employees in improvement and innovation of its business processes for the purpose of survival in a changing environment. Through its deliberate strategy decision, management had prepared the groundwork for employee empowerment. Employees, by communicating their views with management in an iterative way, exercised their power to participate in the development of routines (table 5.13). Furthermore, through the development of BPS the HAL management team established organizational and technical structures supporting routine development, thereby combining computer systems with organizational learning into a deliberate organizational learning model.

Our findings identify an iterative dialogue between management and employees regarding the development of operating routines and processes and where empowerment has been vested in the employee/teams. This vested trust is used by individuals and teams to participate in development of operating routines through a deliberate learning mechanism, such as BPS. Furthermore, our data is supported by informants confirming that they understand, agree to, and find empowerment present in HAL. On this basis we argue that the degree to which employee/teams succeeds with developing best practice routines is dependent on management's ability to empower employee participation through a deliberate learning system where sharing experience is central. We can from the above analysis state the following proposition:

> ***P3a: When employees are empowered to participate in an ICT-supported deliberate routine development process it is likely they will also participate through sharing of their experience.***

We found that, while routine development occurs with the support of ICT, it is not the case that it will always occur or happen in all situations. The deliberate learning model is important when a workforce is asked to participate in the development of routines. We consider the

deliberate learning process to be a contributing factor in employees' willingness to share codified experience. From our informants, we were told that once an individual or group had forwarded some experience, the PL/Superuser would engage in a dialogue. This dialogue is important when a workforce is asked to participate in the development of routines. However, we have learned through our stories that some of the foremen do not share senior management's acclamation for employee participation. One informant told us that often some of the foremen did not bother to answer employees' suggestions for improvement, which resulted in a virtual stop of feedback from operators reporting to these managers. Should this attitude prevail and spread throughout the organization, employee participation will stop. Thus, some managers may put in jeopardy a strategic intent having taken management several years to implement. We propose the following proposition:

> ***P3b: Development of routines through empowerment relies on an employee-management nested iteration process. Deliberate organizational learning void of multilevel nested iteration will most likely not work.***

Furthermore, we found evidence of possible avoidance of experience sharing due to an assumption by employees that management had the authority to always know. In spite of an empowerment regime, some employees may find it presumptuous that management is interested in their experience. Such refusal to share ones experience with management, while at the same time continue to practice it and perhaps demonstrate it for close colleagues, may lead to myopic learning and stifling of development processes. The following proposition can now be developed:

> ***P3c: Managerial authority may prevent employees from sharing experience with management, resulting in possible myopic learning and stifling of organizational development.***

Above we argued that organizational learning and routine development are context specific, idiosyncratic, and industry specific. This is then reflected as cognitive maps within the head of individual employees in form of absorptive capacity (Cohen & Levinthal, 1990). However, according to Brown and Duguid (1991) new operative knowledge, to be learned by experienced technical personnel, is best learned through a story-telling process within a community-of-practice.

According to our findings, the informants told us that they were perfectly able to understand the implication of a new routine transferred to them on a computer or an overhead screen.

They also argued on behalf of their colleagues, pointing out that they did not know of any experienced employee not understanding new routines being presented on a computer. Furthermore, our findings suggest a difference in employee attitude between the old and the new ICT system. While SDOCS was used only marginally, and some even undermined it by not using it at all, BPS is used by most of the informants. On this basis we argue that, provided an ICT-supported deliberate organizational learning model is being used, when experienced employees' ability and dedication to learn new routines are present, they will most likely be able to learn routines stored in computers for the purpose of implementation. On this basis we propose to enlarge Brown and Duguid's (1991) theory by making the following addition:

> ***P3d: When experienced employees' ability and dedication to learn new routines are present, they will most likely be able to learn and apply new routines stored in an ICT-supported deliberate organizational learning structure.***

In conjunction with the learning question we asked if employees considered themselves *newcomers* since they had to learn new routines or new work processes (ref. Lave & Wenger, 1991). None of the informants, or colleagues of the informants, considered themselves a newcomer or an apprentice as a result of having to learn a new routine or a new work process. Thus, within the area of this research's operational context, experienced employees will consider themselves both experienced and capable individuals, and not as newcomers when a new routine is presented. On this basis we propose an addition to Lave and Wenger's (1991) theory:

> ***P3e: Experienced employees, operating within the context of an industrial setting, do not consider themselves newcomers when a new routine is being learned.***

6.3 Summary

So far in this chapter, we have seen that, based on a cognitive/behavioral research perspective on organizational learning, combined with new empirical findings, computers can support organizational learning and routine development within an organization. This can be done thrugh a deliberate leaning mechanism established by management in a strategy to empower employees to participate in the routine development process. We found that empowerment and knowledge management are concepts that support an organization's successful use of ICT in developing operating routines. We will conclude this chapter with a section on discussion and findings.

6.4 Discussion and findings

We have been able to confirm our original research question that ICT supports organizational learning and development of routines. However, in order to apply ICT in relation to routine development, the organization must be able to learn through an explicit learning process with multilevel nested iteration. Such process is dependent on management policy and strategy. It is not just a matter of providing a computer system for an organization and letting it take care of routine development. It requires of management a strategy to develop a deliberate organizational learning model offering dynamic capabilities. Furthermore, we found evidence of the presence of concepts, such as empowerment and knowledge management.

Whenever an otherwise capable employee with access to a computer, is unwilling to participate, it may be due to motivational and/or systemic factors. In applying SDOCS, many employees were unwilling to use it, while they were willing to use BPS. In order to find explanation for this, we will turn to *empowerment*. From both employees and management, and supported by Thorsrud and Emery (1969), we know that this concept is important for the organization in order for employees to participate in routine development. Empowerment may be a strong determinant for employees in their use of ICT, but empowerment will only explain the participation in routine development, that is sharing, and not the use of ICT. Thus, we have to apply an additional factor which we found played a role in changing employees' minds about BPS - *knowledge management*.

Above we have discussed knowledge management, and suggested improving its concept by proposing to include systemic innovation and media richness. These concepts can explain how an organization is able to learn through ICT-supported knowledge representation, that is, absence of these elements may prevent employees from using and learning from it. While non-involvement can result in lack of motivation for applying a system, absence of information and the possibility for multiple interpretations can prevent represented knowledge from being learned. Our informants identified SDOCS as not useful to them, while BPS was useful. When we know that employees had been participating in both the design and worked out the content of BPS, while none of it in SDOCS, BPS fulfilled both systemic innovation and media richness, while SDOCS did not. But without the presence of empowerment employees may not participate in routine development. Hence, empowerment in combination

with knowledge management may seem to make a difference in securing employee participation using ICT.

We also found indications that *communities of practice* (COP) were present in HAL. In particular, we can say that COP was present in the discussion and revision of BPS. Figure 5.2 illustrate the use of BPS for the purpose of improving the system. Also, the use of BPS to send experiences to Superusers supports the formation of a COP for BPS. We found that the more knowledge an employee had about his area of operation the more *absorptive capacity* s/he had in relation to new routines or technology. For example, the promotion of a new technology led one of the informants to an information search. The informant had no problem with understanding the data which he found on the computer. Based on this data he was able to articulate the benefits of this new technology to his team. Because he was listened to, HAL acquired the technology, and our informant was able to apply it to a set of furnaces for testing. In another situation, employees were presented with a new routine on an overhead in an office. From this they had to learn how to operate the new technology they were presented with. The longer one stays in a job, our informants tell us, the easier it is to understand new concepts being brought into the operation. Thus, being able to understand new routines or new technologies through a computer presentation is a question of ones absorptive capacity. Thus, we did not find support for the theory that learning through a community of practice takes place only through social/cultural behaviors as argued by Brown and Duguid (1991). Although the master-apprentice learning relationship is valuable, perhaps the only way in certain cases of learning a technique or a trade (Cook and Yanow, 1993), our data indicate that employees are capable of learning new knowledge represented through a computer. Within the area of an industrial setting, where the value creation is goods-producing, COP members can, given the right circumstances, learn though computer supported knowledge representation.

Lave and Wenger's (1991) current industrial information domain theory arguing that experienced members of a community consider themselves newcomers each time a new routine was being presented was not supported by our informants. According to their theory legitimate practitioners of core activities can at times become "peripheral in some respect. In other words, everyone can to some degree be considered a "newcomer" to the future of a changing community" (Lave & Wenger, 1991: 182). None of the informants in our interviews saw themselves as newcomers whenever a new technology or routine was to be

learned. Thus, we will argue that the Lave-Wenger theory does not apply to an industrial setting where the value creation is goods-producing.

Based on the discussion in this chapter, we would like to expand Zollo and Winter's (2002) theory to include a cognitive/behavioral perspective. We have argued that in order for an organization to learn and develop new routines supported by ICT, it needs an integrated deliberate organizational learning model containing an organizational structure capable of handling the dynamic process. Thus, an expansion to the theory should include an organizational suitable for processing (1) ICT-supported multilevel nested iteration. This secures a functional DOLM. However, in order for employees to feel invited to participate in the deliberate organizational learning process, some additional elements need to be present in the organization: (2) empowerment, (3) knowledge management. Empowerment explains employees' participation in organizational learning and routine development; while knowledge management explains employees' willingness to use ICT. We also tested employees' ability to absorb new knowledge which explains why employees are able to learn from new routines found in computers. Any organization planning to improve routine development through the application of ICT needs therefore to consider these phenomena in their approach to the issue. In the final chapter we will identify contributions made, cite limitations, discuss implications, and propose future research directions.

7 Implications and concluding remarks

This chapter consists of implications and conclusions. A brief summary, emphasizing the main contributions of the study, leads up to identification of limitations and a presentation of practical implications. Theoretical implications and suggestions for future research follow.

7.1 Contributions

The context within which this case study has been performed is the production industry. It is a longitudinal study of how representation of knowledge stored in ICT can contribute to enhancing the development of operating routines within a nested organizational structure. In this context we have developed a model for deliberate organizational learning (DOLM). The main contributions of this work, to be elaborated below, are:

- Development of routines is enhanced through ICT-supported deliberate organizational learning that takes place in a nested organization through the application of iterative processes.
- Employees participating directly, or indirectly, in the design of ICT systems are positive to applying such systems for the purpose of developing routines.
- Empowered employees are willing to participate in the development of single and double loop operational routines by sharing experience through ICT, resulting in enhanced productivity.
- Because of their capacity to absorb, experienced operational personnel understand new routines presented through ICT-supported deliberate organizational learning structures.

Development of routines is enhanced through ICT-supported deliberate organizational learning that takes place in a nested organization through the application of iterative processes.

Many people take it for granted that computers support organizational learning, yet to the best of our knowledge little imperial proof has been forthcoming through the literature. While Huber (1991) and Levitt and March (1988) point out that organizations learn through organizational memory, these are only theories that have to be tested. Our findings, based on an in-depth longitudinal study of an industrial organization, clearly demonstrate that organizations learn through the support of a properly structured and user friendly learning system. However, for organizations to learn through the support of ICT-represented

knowledge, such system must be an intrinsic part of a deliberate organizational learning strategy. Such deliberate strategy must include a nested and iterative learning process where a dialogue between relevant organizational levels can take place through the support of computers. Hence, our data enhances Zollo and Winter's (2002) evolutionary development theory by adding the cognitive/behavioral theory to organizational learning. *Our case identifies multilevel nested iteration within a deliberate organizational learning model, aided by a computer-based knowledge system, as the mechanism through which organizations develop operating routines.*

Employees participating directly, or indirectly, in the design of ICT systems are positive to applying such systems for the purpose of developing routines.

Systemic innovation (Grønhaug & Kolltveit, 2005) explains why people may be positive to something they participated in designing, while oppose to something new which they did not participate in developing. Our findings confirm this theory. However, our findings extent beyond the literature by including colleagues who knew someone participating in the design process and thus consider themselves positive to the application of the new system. Thus, we enlarge the theory on systemic innovation by adding that also *employees doing indirect participation are positive to using computer systems*. Furthermore, the purpose of such use may be to participate in the development of operating routines.

Empowered employees are willing to participate in the development of single and double loop operational routines by sharing experience through ICT, resulting in enhanced productivity.

According to theory on empowerment (Thorsrud & Emery, 1969) empowered employees support the development of the organization. However, the theory does not say anything about employees' willingness to apply ICT in the pursuit of developing routines, nor does it suggest that employees are willing to share experience through computers. Our findings deal with these issues. There is in our data a clear indication that empowered employees are willing to participate in the organization's development of routines by using an integrated deliberate organizational learning system, such as a KMS. Furthermore, our informants are willing to share accumulated experience through feedback functions found in a deliberate KMS. Thus, we enlarge the empowerment theory by adding that *empowered employees are willing to participate in the development of single and double loop operational routines by sharing experience through ICT.*

Because of their capacity to absorb, experienced operational personnel understand new routines presented through ICT-supported deliberate organizational learning structures.

It has been argued by Brown and Duguid (1991) that experienced technical employees learning new routines need to learn through story-telling within a community-of-practice (COP). Our data indicates that learning from others' experience also can take place through ICT. For experienced operating employees it is possible to learn new routines because they possess a mental frame capable of absorbing new, subject related and context specific, knowledge. According to Cohen and Levinthal's (1990) absorptive capacity theory, knowledge will diffuse more rapidly among employees who have prior experience. While the theory on COP argues that organizational learning among technical personnel takes place through storytelling, our data indicate that new operating routines transferred to experienced operators can be learned through ICT. Thus, we propose to enlarge the COP theory by adding that *experienced operators can learn new routines through ICT-supported deliberate organizational learning structures.*

Our case study shows that routine development can take place with ICT-supported knowledge representation. Furthermore, this study explains how, and under which circumstances, operating routines are developed and learned through ICT-supported knowledge representation. A tentative research model was developed based on the organizational learning literature. Also by reviewing different literature trends which have emerged within organizational learning within the last 10-15 years, such as organizational knowledge, social/cultural learning, learning organizations and knowledge management, we hoped to simplify the identification of the theory we would need in order to describe the research question. This literature review, while useful in our initial research, was found to be incomplete in answering the research question. The inductive analysis of the applied theories concluded that routine development using ICT was not treated to any extent.

A major reason for a cognitive/behavioral approach to routine development using ICT as a supporting structure has been suggested. Some of the theories listed above suggest that routine development either had to be done by management, or if employees were to be involved, learning new routines had to be done through social/cultural processes. *This research contributes to the understanding that development of routines can take place through nested multilevel deliberate organizational learning supported by an ICT structure when conditions of employee-empowered participation are present.*

Thus, this research contributes to theory building by arguing that given certain conditions ICT can support organizational learning. Furthermore, this research contributes by identifying how ICT can support routine development, and under which conditions such development can succeed. Different types of ICT systems were tested with the purpose of finding out under which system organizational learning and routine development succeeded, identifying a KM system as the most successful. These findings help us to establish strategies which imply developing dynamic organizational capabilities. The findings also emphasis the importance of empowerment and systemic innovation, as it focuses on the inclusion of employees in the process of system design, organizational learning and routine development. In this sense strategy, change processes and KM systems are intrinsically linked. Existing theories related to organizational learning and routine development do not encompass the application of deliberate organizational learning through the use of ICT, and thus may not support organizations in a dynamic routine development process.

7.2 Limitations

The most obvious limitation of his study, as with most case studies, concerns the possibilities to generalize from the findings and the objectivity of the findings.

Case study consists of one or several cases. Our study is an embedded case study with comparative units, with organization as the level of analysis, and operating routines unit of analysis. Such a case study does not allow for generalization to a greater population. In this inductive study, the goal was to build theory from data and hence to generalize to theory, not to a larger population. The application of the theoretical model that was developed can only be assessed through future studies.

Another well-known limitation of qualitative studies is the question of objectivity. Qualitative researchers cannot avoid bringing some of their own ideas and meanings into the research. While there is always a risk that data collection is affected by a subjective researcher, all interview data were transcribed verbatim and all interviews and secondary documentation are available in a database, or printed version (those documents we have been receiving physically), and can be recoded and analyzed again. The analysis procedures have been described carefully and specifically to allow other researchers to follow the theory-building process.

While precautions have been taken to increase the validity and reliability of the study, there is always a risk that another researcher would come to quite different conclusions based on the same data material.

7.3 Practical implications

A case study has as one of its objectives to build theory based on imperial findings. We have in 7.1 identified which contribution our findings make to theory. However, application of ICT in the development of organizational knowledge is not just a matter of installing a computer and run with it. The management at HAL had as their strategy to involve employees in the strategy of being the most innovative organization within the aluminum industry, bringing organizational learning up to the strategic level where it belongs, and submit to their vision. It is most likely that HAL's management will consider their strategy successful. Our research provides evidence to the effect that employees have been participating in the development of operating routines, and thus improved productivity, through the support of computer-represented knowledge. This being said, there are many organizations, however, struggling to utilize ICT to its full potential (Brynjolfsson & Hitt, 1998); and the lack of imperial research and theoretical perspectives on implementation and application of computer-supported routine development does not help. This study explores the use of computers in relation to developing routines in a dynamic context, and presents a model for how such a development process can be structured and suggests a theoretical perspective.

A cognitive/behavioral perspective on development of routines predicts that ICT-supported knowledge representation can help improve organizational learning necessary to obtain new, institutionalized, routines. The focus on ICT as a support structure for routine development is by some theories, therefore, perhaps undervalued. If an ICT system, incorporated into a deliberate organizational learning model, is able to enhance routine development and productivity why spend so much money on ICT without actually allowing the organization its full value? Employees will always see opportunities to enhance their work processes and thus develop more or less productive ways to handle a task, regardless of institutionalized routines. The question is how the corporation can capture these creative processes in a way that may benefit the organization, and thus avoid myopic and other ill-conceived learning? Only a recognition, and understanding, of the cognitive/behavioral processes that occurs at all levels

in the organization over time, can improve the likelihood of success in future routine development processes.

From an organizational learning perspective the findings in this study have practical implications for: (1) strategic processes; (2) routine development and change processes; (3) productivity improvements processes, and (4) the process of develop and implement knowledge management systems. Furthermore, our findings will have implications for development of organizational structures; employee participation; empowerment policy; and absorption of knowledge through ICT.

Managers often operate in a top-down process with regard to strategy and change processes. In this study it was found that by empowering employees to participate in the development of routines these employees were actually participating in changing strategic premises. In a 2005 survey by Boston Consulting Group, 87% of the senior executives interviewed answered that organic growth through innovation will be necessary for success in their industry. Clearly development of routines is an important strategic process when seeking continuous improvement. Organizations need therefore to develop a DOLM structure which will include employees in the process of organizational learning and strategic change. Sticking to a well-established managerial process on strategic change, corporate leaders may demonstrate full control by issuing plans of change. Managers who incorporate employees' experience in their strategic plans may, on the other hand, seem indecisive. However, in a dynamic world, implementing a DOLM structure in the strategic process will allow employees developing double loop learning processes, making the firm stronger and more agile in meeting with new market challenges. Furthermore, a deliberate learning structure will make change a planned process, incorporating employees in the activities.

The findings also have implications for management of multilevel organizational learning. A cognitive/behavioral perspective will support the development of a knowledge organization, as the conversion of accumulated experience can be articulated and codified for storage. Such a memory of organizational knowledge can be tapped into by all employees regardless of situation and location and thus increase the learning rate of the organization. However, a lot of information stored in the organizational memory does not mean that everyone has received and understood its content. There has to be some structural mechanism incorporated into the practice of the organization in order to find relevant information in an accessible structure

making such systems context specific. This, we feel, is missing in much of today's ICT structures within concepts such as Knowledge Management systems. Furthermore, there have to be incentives for employees to participate, by both using and sharing experience, in the development of such a knowledge store. Thus, by a carefully structured DOLM, where the support of a multilevel nested iterative development process is of vital importance, development of routines will be strengthened.

Managers planning to enhance productivity needs to be more attentive to opportunities presented through a deliberate learning structure enhancing routine development. Should success in large-scale productivity only be related to technology? This study suggest that routine development can make an impact on productivity by improving current routines as well as suggesting new routines based on the experience from current production processes. Furthermore, the study shows that by mastering the deliberate learning mechanism through ICT, new technology, such as gas fore-warming, can be proposed and introduced into the production process. Such initiatives from operators are a direct result of a deliberate learning structure.

Implementation of ICT has not produced the payoff in form of increased productivity as foreseen (Brynjolfsson and Hitt, 1996). This study has contributed to the theory by pointing to an area of possible enhanced value creation. By incorporate a deliberate organizational learning system, supported by empowerment and employee-participated process and system design, a carefully initiated management-employee DOLM process can lead to the enhancement of operating routines.

7.4 Theoretical implications and suggestions for future research

The findings in this research have theoretical implications for resource based and organizational learning research. The implications also lead to suggestions for future research. Theoretical implications include rethinking the ability to apply computers as a learning element in the dynamic capability perspective of the resource based view. Within this view the theory on dynamic capabilities needs to implicate the ability by an ICT-based deliberate learning process to support dynamic capabilities. In the dynamic capabilities perspective DOLM become a strategic resource applicable in all aspects of the organization, and at multiple levels.

Organizational learning is a relatively new field. We believe it will benefit from the results of our study where the cognitive/behavioral theory seems able to explain the success of ICT as a support for a routine development process. Our research is undertaken within a goods-producing process industry. As organizational learning is context dependent we can only argue that the theory is applicable within such context. However, we should have liked to know if in fact our results also can be applied to other contexts, such as the service industry. After all, one of the embedded cases was a service function within the production company, a market-service unit. This unit was the most successful user of BPS. Future research should therefore continue working in other contexts to extend the generalization issue.

The cognitive/behavioral theory and organizational learning perspective revealed shortcomings with many existing organizational learning studies. There was a lack of incorporating routine development in general and the application of ICT-supported structure in particular. In discussing organizational learning in the literature, existing research seldom incorporate routine development in relation to ICT application, neither does it include supporting concepts such as empowerment and systemic innovation. Alternative theoretical perspectives can shed light on these types of challenges. Our findings suggest that a deliberate learning perspective, incorporating ICT, can shed some further light on this issue. The organizational learning perspective on routine development should also raise additional questions. Based on the statement by one of our IT-capable informant's reluctance to apply computers at work, future research should follow up on Orlikowski's (2000) structuration theory where employees possessing medium to good technical capabilities still are reluctant to apply computers, and link this theory with systemic innovation to find out how one can expand on the lack of willingness to use ICT beyond what has been pointed out in this study. This has both theoretical and practical implications. The practical implication is that there is no point in building expensive ICT structures if that which motivate an employee to participate in its use, is not included in the organizational/system structure. The only way to find out is by focusing theoretical work toward the phenomenon.

Finally we would like to comment on the use of single vs. double loop learning. According to Argyris and Schön (1996) while single loop learning is changes to a routine within a current strategy, double loop learning is changes to the process which makes this strategy. A routine by itself does nothing. At the point where we start to apply the routine, we cannot possible know which impact the experience from its practice will make on the process. Consequently

we need to accumulate practice before considering how many loops of learning it will produce. We need a better understanding of the consequences deliberate learning processes has, using an ICT structure, on the organizational learning theory to Argyris and Schön.

7.5 Closing remarks

Looking back at what has been presented and discussed in this thesis, we have one closing remark that we would like to share with the readers. Having spent over 30 years in the industry, we started out asking ourselves why so much literature focused on tacit knowledge in connection with organizational learning. In spite of universities, schools, business organizations and government, emphasizing applied written documentation in relation to leaning a new legal document, a new theory, a new business proposal and a new routine, literature often focuses on difficulties in transferring codified knowledge. While we have tried to stay focused on our task, more work need to focus on why so many theoretical contributions argue that organizational learning, as we have defined it in our thesis, can only be achieved through story-telling within communities-of-practice theories. We will agree that in some contexts, such as technical development work, communities-of-practice is by far the most preferable. Our case also alludes to this aspect as the improvement of BPS is in itself a case of community-of-practice participation. However, to allow theoretical papers access to serious publications, without making the distinction of the research context absolutely clear, can for a theoretically untrained eye, such as a business leader, be misleading, and should be refused.

Appendix A: Glossary of related terms

ALCOA

US-based aluminum company, and the world's largest.

BPS

BestPracticeSystem: a computer-based Business System containing all routines applied to the sectors in HAL.

CEO

Chief Executive Officer. Senior manager in Hydro Aluminium.

CIT

Critical Incidents Technique

CSFM

Critical Success Factor Method.

HAL

Hydro Aluminium AS, an international integrated aluminum producer and part of Norsk Hydro ASA (Hydro).

HES

Health, Environment, and Safety. A term applied to activities related to standards within the three areas.

ICT

Information and Communication Technology.

KEC

Knowledge Evolution Cycle (Zollo and Winter, 2002).

KPI

Key Performance Indicators: a strategic measure on the operation. A target for management to reach for in the designated period.

MP

Metal Products take the raw aluminum and convert it to customer-specific alloys. We can call MP a mid-stream production process.

MP-MS

Metal Products - Marketing and Sales. The market and sales support unit located in Karmøy, and the coordinator for about 35-40 employees throughout Europe.

PL

Process Leader: Appointed by the senior manager for a process to secure daily maintenance of the process, including any corrections to the process.

PM

Primary Metal is the upstream sector within HAL, responsible for producing raw aluminum from oxide.

PO

Process Owner: The senior manager responsible for an operating process.

OL

Organizational Learning

R/OR

Routine/Operating Routine. We will in this thesis apply ‘routine’ and ‘operating routine’ interchangeable.

RD

Routine Development

With ‘routine development’ we imply ‘operating routine development’.

SDOCS

An IT system for handling operating procedural documents.

Superuser

An employee organized in a business unit, but with functional relationship to a PL, responsible for updating the business unit's local section of BPS.

Supervisor

A lower management position within HAL business units.

VBM

Value Based Management - a method applied by HAL.

Appendix B: References

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Appendix C: Example of an Interview Guide

HAL Intervju

Karmøy/Høyanger Fabrikker

2003

- Vi ønsker å finne ut om bruken av HAL Business System (HAL-BS) kan føre til
  - Økt kunnskapsutvikling som
  - resulterer i økt verdiskaping
  - Dersom HAL-BS brukes
    - Hvem bruker det
    - Hvordan brukes det og
    - Under hvilken forutsetning brukes det
- Sprøsmålsgrupper
  - Litt om deltakerne
  - Deltakers erfaring og oppgaver
  - Deling av erfaring og informasjon i virksomheten
  - Organisasjonen
  - Hendelser: Kritiske, Rutinemessige, Produksjonsstans
  - Avslutningsspørsmål
- Hvilken avdeling tilhører deltaker
  - Hva er avdelingens oppgaver
  - Hvilken konkret jobb har deltaker
  - Hvor lenge har deltaker jobbet med disse oppgaver
  - Deltakers bruk av HAL-BS
  - Bruker daglig
  - I hvilken omgivelser brukes systemet
  - Kjent med
  - Bruker av og til
  - I hvilken sammenheng brukes systemet
  - Er det nødvendig/pålagt å bruke systemet
  - Er det ønskelig å bruke systemet i andre situasjoner
  - Ikke kjent med

- Deltakers erfaring og oppgaver (1)
  - Erfaring
  - Du sa at du jobbet med…
  - Hvor lenge har du jobbet med disse oppgaver
  - Har du oppgaver som krever at du søker i HAL-BS for informasjon?
  - Kan du gi en beskrivelse/demonstrasjon på hvordan du skaffer frem for eksempel et styrende dokument?
  - Når du har fremskaffet dokumentet, hvordan bruker du det i forhold til din jobb?
  - Hva er de mest positive sider ved HAL-BS?
  - Hvilken områder av HAL-BS krever forbedring/endring?
  - Dersom du fikk bestemme, hva ville du ha valgt først, osv.
  - Videreutvikle HAL-BS, i så fall hva?
  - Erstatte det med det gamle systemet?
  - Lage et annet system?
  - Unngått å måtte bruke et system?
- Deltakers erfaring og oppgaver (2)
  - Oppgavens natur
  - Hvordan vil du karakterisere dine oppgaver:
  - Kompleks/enkle
  - Krever jobben din at du tar mange elle få del-beslutninger pr. oppgave
  - Hvor ofte gjentas dine oppgaver:
  - Oftere enn daglig
  - Daglig
  - Ukentlig
  - Sjeldnere enn ukentlig
  - Er jobben din del av en prosess eller frittstående?
- Dele erfaring og informasjon (1)
  - Deling generelt
  - Er det vanlig å fortelle om sine erfaringer i jobbsammenheng? Hvis ja:
  - Hvordan
  - Muntlig
  - Skriftlig
  - All erfaring eller spesielle hendelser

  - Med hvem
  - Arbeidskolleger på samme skift
  - Alle som har interesse
  - Formannen
  - Hvorfor (eventl.) deles erfaring/informasjon?
  - Kulturelt betinget
  - Ledelseskrav
  - Gjøres kun i spesielle omstandigheter
  - Andre årsaker
- Dele erfaring og informasjon (2)
  - Deling ved å benytte HAL-BS
  - Har du kjennskap til om noen legger sin egen erfaring inn på HAL-BS?
  - Hvor ofte legges informasjon inn?
  - Daglig/Ukentlig/ Månedlig
  - Har du kjennskap til om noen bruker erfaringen som ligger på HAL-BS?
  - Hvor ofte hentes informasjon ut?
  - Daglig/Ukentlig/Månedlig?
  - Har du kjennskap til om det er noen i ledelsen som
  - Leser erfaringene i HAL-BS
  - Bruker erfaringene til å videreutvikle
  - Prosesser
  - Produkter
  - Beste praksis
  - Har du kjennskap til om noen av medarbeidernes erfaring som v.h.a. HAL-BS har ført til endringer i prosessene eller produktene? Dersom ja:
  - Hvordan fikk du greie på dette
  - Er du enig/uenig i endringen
- Organisasjon
  - Stabil eller dynamisk driftsorganisasjon
  - Ser en bort ifra den hektiske perioden rundt oppkjøpet av VAW, hvordan vil du karakterisere HAL's daglige virksomhet:
  - Stabil drift?
  - Dynamiske endringsprosesser?
  - Struktur

  - Hvor mange ledere er det mellom deg og Adm. Dir. Nilsen?
  - Organisering av oppgaver
  - Oppgaver kan bestå av både
  - Daglige, rutinepreget aktiviteter
  - Spesielle prosjekt som må løses
  - Hvordan organiseres/bemannes disse oppgavene?
  - På hvilken måte støtter HAB-BS disse to arbeidsformene
  - Bemanning i forhold til aktivitetene
  - Innenfor ditt område vil du karakteriosere bemanningen som Riktig – Over – Under-bemannet?
  - På hvilken måte vil du si at HAL-BS bidrar i forhold til bemaningssituasjonen?
  - Positivt, og på hvilken måte
  - Negativt, og på hvilken måte
- Hendelser (1)
  - Kritiske hendelser
  - Kan du nevne noen typer kritiske hendelser som har skjedd i din jobb/enhet?
  - Hvor ofte skjer dette (f. eks. hendelse x og y)?
  - Finnes det
  - en standard rutine for å håndtere hendelsene x og y?
  - Ligger den rutinen på HAL-BS?
  - La oss fokusere på den hendelsen som har standard rutine, lagret på HAL-BS, men skjer mest sjeldent:
  - Kan du beskrive et hendelsesforløp forut for handling?
  - Hvordan ble hendelsen oppdaget?
  - I handlingsøyeblikket hvordan håndterte du/dere oppgaven?
  - Tenkte dere på andre måter å løse oppgaven på?
  - Hvilken løsning endte dere opp med å velge?
  - Hvordan gjennomførte dere løsningen?
  - Hvordan følgte dere opp hendelsen – overvåking, osv.?
  - Var det noe ved HAL-BS som
  - Forbedret løsningsforløpet
  - Forverret løsningsforløpet
- Hendelser (2)
  - Rutinepreget hendelser

  - Det dukker opp en rutinepreget aktivitet hvor du trenger å konsultere et styrende/prosessbeskrivelse dokument som ligger i HAL-BS:
  - Kan du demonstrere hvordan du løser oppgaven v.h.a. Datamaskinen
  - Etter at en rutinepreget oppgave er løst oppdager du at det kan være en mer effektiv måte å løse oppgaven på, for eksempel ved å redusere antall steg i en prosess:
  - Hvordan håndterer du denne erfaringen?
  - Hvem, hvis noen, tar du kontakt med, og hvordan?
  - Hva forventer du vil kunne skje dersom du tar kontakt?
  - Uønsket Produksjonsstans
  - Hvor ofte skjer produksjonsstans i enheten?
  - Støtter HAL-BS arbeidet med å få i gang drift etter en produksjonsstans?
  - Dersom Ja, på hvilken måte støtter systemet en slik oppstart?
  - Brukes systemet til å redusere/detektere årsakene til produksjonstanns?
- Avslutningsspørsmål
  - I få ord, hvordan vil du oppsummere
  - formålet med HAL-BS?
  - Bruken av systemet
  - Er det områder du føler HAL-BS
  - Er mer nyttig enn andre bruksområder
  - Gir økt verdiskaping
  - Gir bruken av HAL-BS økt trygghet i situasjoner som kritisk hendelse og produksjonsstans?
  - Har du tillit til at informasjon du finner i HAL-BS er de siste oppdaterte?

HAL Intervju

Karmøy & Høyanger Fabrikker

2005

- Vi ønsker å finne ut hvordan SDOC datasystem brukes
  - Hvem bruker det

    - Hvordan brukes det og
    - I hvilken forbindelse brukes det
    - Hvilken oppfatninger medarbeiderne har til systemet

- Følgende spørsmålsområder
    - Litt om deltakerne
    - Deltakers erfaring og oppgaver
    - Deling av erfaring og informasjon i virksomheten
    - Organisasjonen
    - Hendelser: Kritiske, Rutinemessige, Produksjonsstans
    - Avslutningsspørsmål

- Intervju deltaker
    - Deltakers navn og avdelingstilhørighet
    - Hva er avdelingens oppgaver
    - Hvilken konkret jobb har deltaker
    - Hvor lenge har deltaker jobbet med disse oppgavene
    - Deltakers bruk av SDOC
    - Bruker daglig
    - I hvilken situasjon brukes systemet
    - I hvilken omgivelser brukes systemet
    - Kjent med
    - Bruker av og til
    - I hvilken sammenheng brukes systemet
    - Er det nødvendig/pålagt å bruke systemet
    - Er det ønskelig å bruke systemet i andre situasjoner
    - Ikke kjent med

- Deltakers erfaring og oppgaver (1)
    - Erfaring
    - Du sa at du jobbet med…
    - Hvor lenge har du jobbet med disse oppgaver
    - Har du oppgaver som krever at du søker i SDOC for informasjon?

    - Kan du gi en beskrivelse/demonstrasjon på hvordan du skaffer frem for eksempel et styrende dokument i HMS, eller andre steder?
    - Når du har fremskaffet dokumentet, hvordan bruker du det i forhold til din jobb?
    - Hva er de mest positive sider ved SDOC?
    - Hvilken områder av SDOC krever forbedring/endring?
    - Dersom du fikk bestemme, hva ville du ha valgt av følgende alternativ:
    - Videreutvikle SDOC, i så fall hva?
    - Brukt et annet system?
    - Unngått å måtte bruke et system?

- Deltakers erfaring og oppgaver (2)
    - Oppgavens natur
    - Hvordan vil du karakterisere dine oppgaver:
    - Kompleks/enkle
    - Krever jobben din at du tar mange elle få del-beslutninger pr. oppgave
    - Hvor ofte gjentas dine oppgaver:
    - Oftere enn daglig
    - Daglig
    - Ukentlig
    - Sjeldnere enn ukentlig
    - Er jobben din del av en prosess elle frittstående?

- Dele erfaring og informasjon (1)
    - Deling generelt
    - Er det vanlig å fortelle om sine erfaringer i jobbsammenheng? Hvis ja:
    - Hvordan
    - Muntlig
    - Skriftlig
    - All erfaring eller spesielle hendelser
    - Med hvem
    - Arbeidskolleger på samme skift
    - Alle som har interesse
    - Formannen

    - Hvorfor (eventl.) deles erfaring/informasjon?
    - Kulturelt betinget
    - Ledelseskrav
    - Gjøres kun i spesielle omstandigheter
    - Andre årsaker

- Dele erfaring og informasjon (2)
    - Deling ved å benytte SDOC
    - Kan en legge erfaring inn på SDOC?
    - Har du kjennskap til om noen legger sin egen erfaring inn på SDOC?
    - Hvor ofte legges informasjon inn?
    - Daglig/Ukentlig/ Månedlig
    - Har du kjennskap til om noen bruker erfaringen som ligger på SDOC?
    - Hvor ofte hentes informasjon ut?
    - Daglig/Ukentlig/Månedlig?
    - Har du kjennskap til om det er noen i ledelsen som
    - Leser erfaringene i SDOC
    - Bruker erfaringene til å videreutvikle
    - Prosesser
    - Produkter
    - Beste praksis
    - Har du kjennskap til om noen av medarbeidernes erfaring har ført til endringer i prosessene eller produktene? Dersom ja:
    - Hvordan fikk du greie på dette
    - Er du enig/uenig i endringen
    - Ble slike endringer gjort v.h.a. SDOC

- Organisasjon
    - Stabil eller dynamisk driftsorganisasjon
    - Ser en bort ifra den hektiske perioden rundt oppkjøpet av VAW, hvordan vil du karakterisere HAL’s daglige virksomhet:
    - Stabil drift?
    - Dynamiske endringsprosesser?
    - Struktur

    - Hvor mange ledere er det mellom deg og Adm. Dir. Jon-Harald Nilsen?
    - Organisering av oppgaver
    - Oppgaver kan bestå av både
    - Daglige, rutinepreget aktiviteter
    - Spesielle prosjekt som må løses
    - Hvordan organiseres/bemannes disse oppgavene?
    - På hvilken måte støtter SDOC disse to arbeidsformene
    - Bemanning i forhold til aktivitetene
    - Innenfor ditt område vil du karakterisere bemanningen som Riktig – Over – Under-bemannet?
    - På hvilken måte vil du si at SDOC bidrar i forhold til bemaningssituasjonen?
    - Positivt, og på hvilken måte
    - Negativt, og på hvilken måte

- Hendelser (1)
    - Kritiske hendelser
    - Kan du nevne noen typer kritiske hendelser som har skjedd i din jobb/enhet?
    - Hvor ofte skjer dette (f. eks. hendelse x og y)?
    - Finnes det
    - en standard rutine for å håndtere hendelsene x og y?
    - Ligger den rutinen på SDOC?
    - La oss fokusere på den hendelsen som har standard rutine, lagret på SDOC, men skjer mest sjeldent:
    - Kan du beskrive et hendelsesforløp forut for handling?
    - Hvordan ble hendelsen oppdaget?
    - I handlingsøyeblikket hvordan håndterte du/dere oppgaven?
    - Tenkte dere på andre måter å løse oppgaven på?
    - Hvilken løsning endte dere opp med å velge?
    - Hvordan gjennomførte dere løsningen?
    - Hvordan følgte dere opp hendelsen – overvåking, osv.?
    - Var det noe ved SDOC som
    - Forbedret løsningsforløpet
    - Forverret løsningsforløpet

- Hendelser (2)
    - Rutinepreget hendelser
    - Det dukker opp en rutinepreget aktivitet hvor du trenger å konsultere et styrende/prosessbeskrivelse dokument som ligger i SDOC:
    - Kan du demonstrere hvordan du løser oppgaven v.h.a. Datamaskinen
    - Etter at en rutinepreget oppgave er løst oppdager du at det kan være en mer effektiv måte å løse oppgaven på, for eksempel ved å redusere antall steg i en prosess:
    - Hvordan håndterer du denne erfaringen?
    - Hvem, hvis noen, tar du kontakt med, og hvordan?
    - Hva forventer du vil kunne skje dersom du tar kontakt?
    - Uønsket Produksjonsstans
    - Hvor ofte skjer produksjonsstans i enheten?
    - Støtter SDOC arbeidet med å få i gang drift etter en produksjonsstans?
    - Dersom Ja, på hvilken måte støtter systemet en slik oppstart?
    - Brukes systemet til å redusere/detektere årsakene til produksjonstanns?

- Avslutningsspørsmål
    - I få ord, hvordan vil du oppsummere
    - formålet med SDOC?
    - Bruken av systemet
    - Er det områder du føler SDOC
    - Er mer nyttig enn andre bruksområder
    - Gir økt verdiskaping
    - Gir bruken av SDOC økt trygghet i situasjoner som kritisk hendelse og produksjonsstans?
    - Har du tillit til at informasjon du finner i SDOC er de siste oppdaterte?

- HAL Business System
    - I løpet av høsten vil det bli tatt I bruk et datasystem på Høyanger som heter HAL Business System.
    - Har du hørt om dette systemet?
    - Er du kjent med hvilken oppgaver HAL BS skal løse?
    - Regner du med å bruke systemet når det blir tilgjengelig?

- Og i så fall, hva må på plass for a du skal bruke det?
- Hvilken forventninger har du til HAL BS?

Appendix D: Example of a KSFM interview trascript

KSFM - Faktorer: Mål

Director/ Ass. Dir., HAL

Side	Mål	Beskrivelse	Antall
Overordnede mål			
1		Innen 2005 være det mest lønnsomme alu-selskapet i verden.	1
1		Fremstå som et "World Class" selskap.	1
1		Forbedre "Cost of Capital" gjennom hele HAL's verdikjede	1
Underordnede Mål			
1		Verdens dyktigste alu-produsent	1
7		Tjene penger er en forutsetning for det vi ønsker å gjøre.	1
12/13		Sikre at HAL anvender ressurser der hvor de trengs, bruk av PM	1
12/13		Utvikle forbedringskompetanse gjennom "på-jobb-trening"	1
13		Nedbemanning (på 30%) skaper konflikt med øvrige mål	
Personlige mål			
2		Medarbeidernes kompetanse skal heves til et nivå hvor forbedringsledelse gjennom HABS blir en naturlig prosess.	1
7		Sikre at medarbeidernes hverdag får et meningsfylt innhold.	1
7		Lære medarbeiderne lønnsomhet.	1
7		Sikre at HAL når de overordnede mål gjennom anvendelsen av HABS	1
Policy			
2		HAL må utvikle en helhetlig visjon og filosofi	1
2		HAL må sikre gode ledere som kan implementere HALs tankegods	1

KSFM - Factors 1:								
Situasjon: Director / Ass. Dir. Stab, HAL								

Side	Faktor	Beskrivelse	Antall
Eksterne			
		Konkurrenter	1
12		Kunnskap om ALCOA Business System er viktig.	
Interne	**HAL nivå**		
15		Det er en forutsetning for Hydros sukess at ledelse/medarbeidere får sine ledelses/operative og støtte prosessene til å fungere sammen.	1
3/4 15/16		Hydro Aluminium er et hel-integrerte selskap, bestående av gjennomgående forretnings/ledelses-prosesser, som igjen består av flere operative/del-prosesser. Hver del-prosess organisert som egen Sektor: Primary Metal, Metal Products, etc.	1
1		Møte kapitalavkastningskrav gjennom bruk av HABS - Hydro Aluminium Business System	1
1 1		Operasjonalisere Strategi: Bruke HABS til å lukke gapet mellom strategi (world class) og operasjon (worlds best) (metode, team, prosesser)	1
15		Hydros unikness reduseres grunnet for stor avhengighet av konsulenter.	1
	Operasjonelle faktorer		
4	?	Sikre "arbeidsfordeling" mellom PM (som limet) og HABS (som innhold) i HALs styringsstruktur.	1
4		HABS skal ha følgende byggesteiner: Business culture (philosophy) and values Best Practice	1

15		Prosessdrevet BP Hver prosess sin Prosesseier Prosesseier ansvarlig for videreutvikle sin prosess	
		Performance Monitoring/Konkurrent analyse Key Perf. Indicator	
4		Benchmarking Hvordan omforme kultur til handling. SWOT analyse	
2		Improvement management Gjennom en positiv språkbruk gi medarbeiderne trygghet til å delta i utviklingen av Beste Praksis.	
		People Training Team Collaboratory work Empowerment	
15		Sikre støtte fra gode virksomheter til virksomheter som sliter med lønnsomheten.	1

Organisatorisk filosofi

		Ledelsen er god på strategi men dårlig på	
10		organisasjonsutvikling	1
6		Bruk av konsulenter til å mestre store endringer.	1
11		Da får vi ikke inn Hydrokulturen. Det blir raske omveltninger som ikke er forankret i organisasjonen.	
13		Hydro har ingen kultur for å satse på sine medarbeidere.	1
1	?	Sikre metodeutvikling for økt organisatorisk kompetanse	1
		HAL må bli bedre på egen-utviklet	
11	?	organisasjonskultur.	1
11		HABS skal sikre økt organisasjonskompetanse:	1
		Egenutvikling vil styrke HAL i forhold til konsulentbruk	
15		Skal sikre konsulent-uavhengigheten: Medarbeiderne skal jobbe med forbedring/endringspros. Skal gi bedriften økt unikness og derved konkurransefortrinn.	

		Ledelsen må demonstrere HALs kultur: "walk the	
13	?	talk"	1
18		Erfarne ledere sikrer spredning av Hydro kulturen	
11		Sikre at medarbeiderne aksepterer og anvender HAL filosofi	1
13		Sikre medarbeidernes bruk av HABS gjennom "myk" overgang	1
3/4/5/6/7/10/12	?	Forbedrings/endringskompetanse skal sikres gjennom:	1
		Training: Øke breddekunskap, inkl.	
		sosial-, fag-, nettverks-, og performanse kompetanse	
10		Utdanningsbudsjette må økes fra dagens 17 mill/år	
		Collaboratory work: People, Involvement,	
		Participation	
		Utvikle eierskap gjennom gode eksempler	
		Økt læring gjennom "Passport to Excellence"	
		Fokus på insentiver som sikrer anvendelse av ny kunnskap	
		Empowerment: Bygge en organisasjonskultur som	
		setter medarbeiderne i	
		sentrum.	
14		Team: Team-basert kompetanseutvikkling og sertifisering:	
		Samhandling, Regler og Prinsipper, Felles kultur	

Kommunikasjonsfaktorer

		Budskapet om HABS og PM må være klart, presist og	
9		lettfattelig.	1
		Sikre ledelsesforståelsen av HABS gjennom bl.a.	1
7		- en presis formidlingsmåte av budskapet	
8		- å bygge tillit gjennom språk og forståelse	
15		- innsalg hvor HABS øker måloppnåelsen	
17		Åpen informasjon til alle medarbeidere	1

Best Practice case

		Utvikle Karmøy som et demo-senter for	
13		BP	1