CHALMERS

Integration of experiences and new information

Deliverable from IMPRESS sub project 11

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Contents

1 Introduction

This report is the result from the sub project “Integration of experiences and new information” in the CPM funded project IMPRESS (IMPlementation of integRated Environmental information SystemS) running between October 2004 and September 2006.

The report treats the subject of management of environmental knowledge and information in organizations. It contains a state-of-the-art description based on interviews with employees of the CPM companies and literature studies. It analyses how information theories like knowledge management and organizational learning can be used to develop strategies and methods for practical implementation of integration between experiences and new information in industrial companies. Finally, a structure for a systemized management of environmental knowledge and information is suggested.

1.1 The IMPRESS project

The IMPRESS project (acronym for IMPlementation of integRated Environmental information SystemS) ran between 2004 – 2006, and aimed at showing how information, methods and tools that supports environmentally related decisions within the industry, can be integrated with each other and with the corporate business processes and also implemented into the organisations.

The companies participating in the project were Akzo Nobel, Bombardier Transportation, Duni, IKEA, ITT Flygt, SCA and Stora Enso. Research and development work was performed together with the research group Industrial Environmental Informatics (IMI) at Chalmers University of Technology. The project was funded by the Swedish competence Center for environmental assessment of Product and Material systems (CPM).

The overall task of IMPRESS was to implement method and tool integration with business processes in a number of industrial companies. The objectives were to:

- Decrease the cost for industrial environmental management.
- Decrease the cost for developing, using and maintaining data, tools and methods for industrial environmental management.
- Facilitate acquisition of environmental information.
- Provide educational tools for industrial environmental management.

The project also aimed at investigating possibilities for exploitation and dissemination of previous and new CPM results to enhance the value and increase the usability of the results.

The specific methods and tools studied in this project are design for environment (DfE), environmental risk assessment (ERA), and life cycle assessment (LCA) from a product perspective, environmental management systems (EMS) and LCA from a process perspective, and CO_2-emission trading (ET) from a societal perspective. Six industrial application and implementation cases were included in the project:

- Emission trading
- Measurement and communication of environmental performance of products
- Environmental management at site and group level
- Risk management adapted to REACH
- Three tools for IPP
- Integration of experiences and new information

These six cases were studied in detail in close cooperation between IMI and the companies in different sub projects, including e.g. market analyses, specific method development, implementation etc. A general integration methodology was regarded in a separate sub-project. Similarly, technical maintenance for integration, commercialization work, and knowledge exchange was performed in three different sub-projects.

1.2 Goal and scope of sub project 11

The objective of this sub project was to develop strategies and methods to make use of experiences from the environmental work and to keep the tools updated by continuous inflow of new environmentally relevant information.

In this sub project, the existing information flows in organizations has therefore been studied and analyzed. The different ways and effectiveness of how environmental knowledge and information of an organization can be retrieved, stored and communicated is part of the scope. Information on experiences from use of methods and tools is also valuable goods and should be accessible for usage within new work tasks within an organization. This is necessary for sound and conscious choice of methodology data and tools to use by industry, to navigate towards sustainable development. The scope covers thus all environmentally related information within an organization.

As a basis for the strategy and method development, the information theories knowledge management and organizational learning have been studied. The aim with the development of strategies and methods was that they should be adjustable to suit micro and macro scales, e.g. from short and long term, from the choice of methodology to use to the choice of wording in a data field, etc.

1.3 Problem description

The environmental knowledge and information of an organization is retrieved, stored and communicated in different ways. New information is retrieved by the employees from newspapers, scientific reports, suppliers and customers etc. A continuous screening of new environmental information is required to keep the methods and tools used within the organization benchmarked with new developments on related and/or alternative methodology and data.

The knowledge of the employees is primary used to improve the environmental performance of the organization and is sometimes sedimented into documentation, i.e. selected to be stored in databases, routine documents, design requirements, educational material etc. The documented information is then available to other people in the organization and can be everything from numerical data to method descriptions or

experiences from use of a tool or method. When another person is going to make use of the documented information, he or she must begin with sorting out the relevant information for the specific application. The knowledge and experiences of the employees can also be communicated in other ways than as documented information, e.g. it can be personally communicated at meetings or in mail conversations.

How the information management is structured varies between different applications of environmental work, for example LCA and DfE methodologies has seldom any organised information management structure while EMS has in the method description regulated responsibilities and how the information should be used to a certain extent.

As the report will show, a structured way for general management of knowledge and information is not yet developed.

1.4 Perspectives for the analysis

The picture below describes how information is used in an organization to steer towards a sustainable society and is the starting point for the analysis.

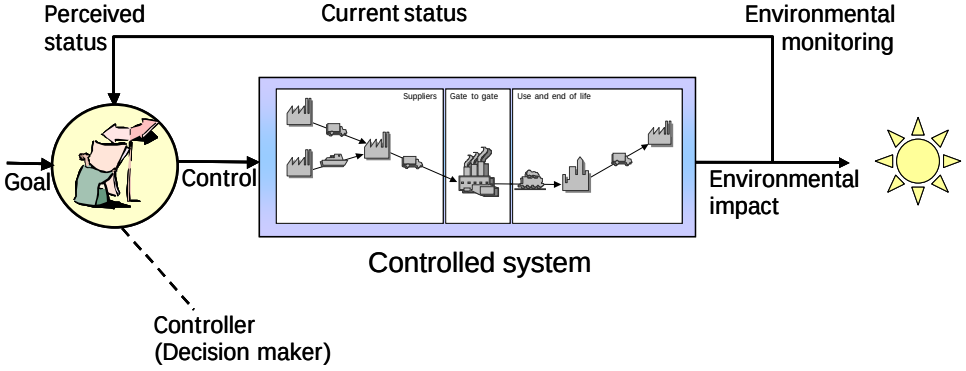

Figure 1. General purpose of information tools for sustainability work. Environmental information is used in an organization to steer towards a sustainable society. Copyright © Raul Carlson, Chalmers University of Technology, 2002

The environmental performance of the organization's activities is measured and reported within the company. Also the condition of the environment (a consequence of many different organization's activities) is measured and reported though usually by other parties than the company, e.g. voluntary environmental movements and communities[1]. The current status of activities and the environment is communicated to the decision makers in the organization (designers, environmental controllers, etc). The decision maker then makes a decision based on the perceived status and the goals for the organization, goals that are influenced by laws and regulations, company policies etc.

[1] Carlson R. et al.; *Establishing common primary data for environmental overview of product life cycles - Users, perspectives, methods, data and information systems*; Swedish EPA Report 5523, 2005

The feedback loop where information of the current status is communicated to the decision maker is put in focus in this subproject. The information system has been structured to ensure that the decision maker can navigate instead of just setting up a goal and then go blindly in that direction. If a company decides that emissions of green house gases is the only important environmental issue, then rationally seen, the resources should be used to reduce green house gases and no other tasks should have resources distributed to them, see figure 2.

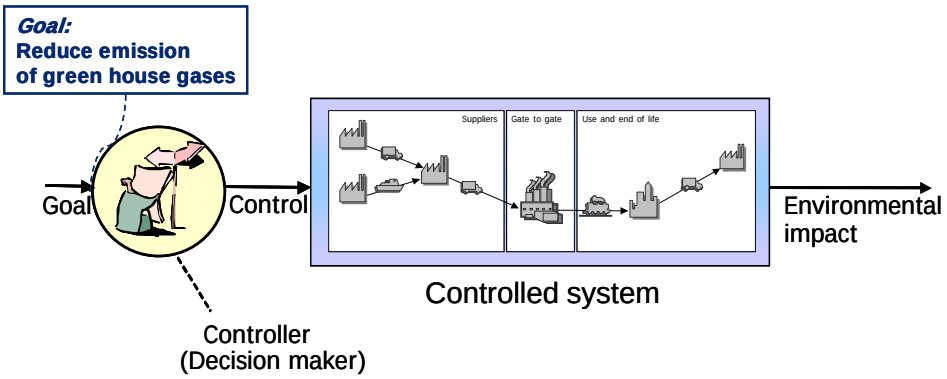

Figure 2. Open loop information system. The goal is no longer sustainability but to reduce emissions of green house gases. All resources are put on achieving the decided goal and none at measuring and communicating the environmental consequences.

The structure of the information system as a navigating system makes it possible to adapt when new knowledge is achieved, a new policy is approved or the external conditions change. Small corrections of the information system at certain time intervals are supposed to be an integral part of it, as figure 3 describes.

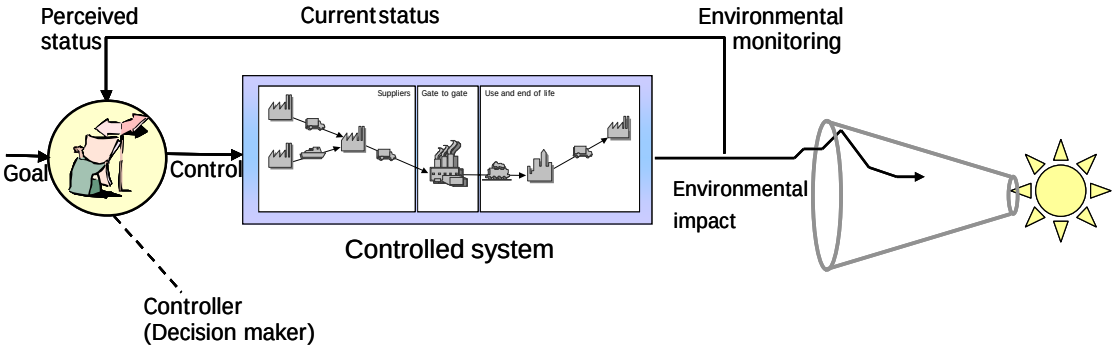

Figure 3. The navigation model. The controlled system steers towards sustainability according to the current conditions and available knowledge. The direction can be altered when more information is acquired. The funnel represents limitations not known when the system was created, e.g. threshold values for environmental stress.

A practical example of a change in the navigation system is the addition of new indicators when a new environmental hazard is perceived.

2 State-of-the-art description

A state-of-the-art analysis of integration between experiences and new information was made both in industry and in literature.

2.1 Integration between experiences and new information in CPM companies

A state-of-the-art analysis of how experiences and new information are integrated in industry today was performed with a series of interviews with representatives of the CPM companies. The interviews were performed in March and April 2005 by Johan Tivander and Sandra Häggström at IMI. The interviewees were:

Ulrika Ågren and Ola Svending, Stora Enso
Saemundur Weaving, Bombardier Transportation
Klas Hallberg, Akzo Nobel Surfactants
Lennart Swanström, ABB
Ellen Riise, SCA Personal Care

The results have been summarized with the following perspectives on environmental information:

- **use** of environmental information
- **cost** of bad environmental information
- **content** of environmental information
- **channels** for environmental information, and
- **obstacles** for environmental information

2.1.1 Use of environmental information

A distinction can be made between *daily activities* and *occasional situations*.

Daily activities where environmental information is used are e.g.:

- Environmental assessments and analyses of products and processes
- Environmental arguments for bids and tenders
- Application/reporting for environmental permissions
- Creation of technical specifications
- Other decisions and advices concerning environmental issues

Occasional situations that occur more seldom are e.g.:

- Handing over environmental work tasks to another person
- Updating lists (environmental aspects, materials, restricted/prohibited)
- Setting environmental goals, targets and policies

2.1.2 Cost of bad environmental information

The cost of not having accurate, updated and sufficient information can lead to:

- Product redesign
- Liabilities and penalty fees

- Loss of goodwill
- Health or environmental risks
- Product not approved

2.1.3 Content of environmental information

The environmental information in the organization consists of information about the social, the nature and the technical system.

Social system:

- Laws and regulations
- Policies, objectives, goals, targets
- Customer requirements

Nature system:

- Environmental impact assessment results
- Life cycle assessment results
- Material property data

Technical system:

- Permits and permit requirements
- Results from measurements and tests
- Best practices
- Use scenarios of products
- Material/product classification lists
- Safety Data Sheets
- Environmental aspects
- Product design data
- Follow-up on results from decisions

2.1.4 Channels for environmental information

The channels available for communication of information in an organization, and their advantages and disadvantages, are typically:

- **Meetings.** Meetings include all face-to-face dialogues, e.g. conferences, education and traditional meetings. The big disadvantage with meeting is the cost as they consume working time for all the involved people. The advantage is that communication is facilitated by a personal relation.
- **Phone calls.** Phone calls include e.g. phone meetings, phone conferences and ordinary phone calls. They are less costly and it is therefore easier to handle issues that are considered as too small to bring up at meetings. Phone calls and meetings have that in common that it is possible to make sure that the information is correctly understood.
- **Emails.** Emails are so cheap and simple that it tends to be an overused form of communication. Compared to meetings and phone calls, emails have the advantage of being possible to use by oneself, and is thus a tool that is available at any time.

- **Databases.** Databases have the big advantage of being structured. It is therefore possible to be exact in the communication of information i.e. delivering neither more nor less information than was requested, and thus minimize the time consumed by the user to find the right information. The disadvantage is that the user interface of databases is not always user friendly.
- **Documents.** Documents are a common way to communicate information between companies, and it is often required by law that documents like safety data sheets and risk assessments are exchanged in connection with trade of products. The documents have often an agreed format which facilitate interpretation of the information, but are costly to produce and update.
- **Intranets.** Intranets communicate information available at all time to many people at a low cost and they are technically simple to use. The disadvantages are that few people actually use the intranets and that they often lack the necessary structure to make the requested information easy to find.

None of the tools is complete, but can complement each other in an efficient way.
The advantages and disadvantages with different tools are summarized in the table below:

	Weakness/ Strenght	Meetings	Phone calls	Email	Databases	Documents	Intranet
Qualities of the ideal system in the interviews	Is commonly used	+	+	+	+	+	-
	Completeness of information	+	-	-	-	-	-
	Easy to use	+	+	+	-	-	-
	Easy to update information	+	+	+	-	-	-
	Cost[2]	-	-	-	+	-	+
	Clearly defined information scope	-	-	-	+	+	-
	Consistent communication of information	-	-	-	+	+	+
Other important qualities	Is available at all times	-	-	+	+	+	+
	Feedback if info is understood	+	+	-	-	-	-
	Structured[3]	-	-	-	+	+	-
	Able to manage odd/small questions	-	+	+	-	-	+

Table 1: The table is constructed to point out weaknesses and strengths and is not meant to give a "true" picture of the tools.

[2] Cost includes man-hours consumed to find the information needed and to document new information as well as maintenance cost for the information system.
[3] With structured is meant e.g. the ability to search for and find information.

2.1.5 Obstacles for environmental information

The obstacles for effective acquisition, storage and communication of information can depend on both the information itself and the information system. Some common problems are listed below:

Information gaps:

- The information is missing, also at the supplier company
- Meta data, background information to facts and figures is not attached
- Unexpected need for information (in case of accidents or natural disasters)
- Odd information is difficult to get access to in a large business group

Unavailable interpretation:

- Comparison of technical, economical and environmental gain
- Information about previous solutions and decisions

Structure deficiencies:

- The information is not structured so that it can be directed to the actual users
- The contents of different pieces of information overlap
- The information is not documented on a reusable format
- Linguistic and semantic difficulties
- High cost of updating information

Information system obstacles:

- Company structure
- Technophobia

2.1.6 Other conclusions from the interviews

Environmental information differs from other information in certain ways. For once, it is rarely asked for and needs often to be pushed out to the users. Further, it is considered secondary to economic and technical information, and is not always given the same weight as decision basis.

The ideal management system for environmental information has certain qualities according to the interviewees: it is complete, simple to use, cheap, updated, exact, and, more importantly, it *is used* in the organization.

2.2 Integration between experiences and new information in literature

2.2.1 Acquisition of new knowledge

Many companies have systems for acquisition of new information about events, trends, and relationships in the surrounding world, commonly called business information systems (BIS). A business information system is usually an external service provided by

a consultant company[4]. Relevant pieces of information are sorted out from the enormous amount of information that is available in newspapers, at the internet and other sources, and are delivered to employees, which can also actively use the IS to search for more information.

The existing sorting techniques are many. The sorting can be based on semantic and syntactic selection principles, induced from a set of pre-categorized documents. Another example is the event detection technique[5]. The news story is classified into a relevant topic from event properties such as when the event occurred, who was involved, where it took place, how it happened, and the impact, significance, or consequence of the event on the intended audience.

2.2.2 Managements of experiences

There are many theories about how information and knowledge are best managed in an organization, e.g. the PD (Participatory Design)[6] and the IRM (Information Resource Management)[7] theory. The PD theory aims to satisfy the user with tailored design and the IRM theory aim to globalize and generalize the information management. A study has been made where the user friendliness of intranets have been investigated when applying either of these theories[8].

A mapping of the organization; the processes, tasks and the employees who perform them has been made at different organizations to streamline the work as well as the information flow[9, 10, 11].

[4] E.g. by Factiva, http://www.factiva.com/business-information-system.html
[5] Chih-Ping Wei, Yen-Hsien Lee, *Event detection from online news documents for supporting environmental scanning*, Department of Information Management, College of Management, National Sun Yat-Sen University, Kaohsiung, Taiwan, ROC, 2004
[6] Sjöberg C., *Activities, Voices and Areas, Participatory Design in Practice*, Department of Computer and Information Science, Linköping Universitiy, 1996
[7] Axelsson K. och Goldkuhl G., *Strukturering av Informationssystem – arkitekturstrategier i teori och praktik*, Studentlitteratur, 1998
[8] Aida Hadziselimovic, Kristin Jansson, *Intranät; Ett humant verktyg?*, Magisteruppsats 20 p. Institution för Informatik, Handelshögskolan, Göteborgs Universitet, 2001
[9] Victor Theander, *En livflotte för att slippa bli dränkt*, Digiscope, Stockholm, viewed at http://www.crmnytt.com/inlagg.htm
[10] Statlig inköpssamordning, Ekonomistyrningsverket, viewed at: http://www.avropa.nu/
[11] Arkivverket, Helsingfors, viewed at: http://www.narc.fi/ams_swe/

3 Literature study on information theories

3.1 Introduction

3.1.1 Goal and scope

The goal of the literature study was to find the most important actors and work that has been performed in the two areas of knowledge management and organizational learning, i.e. benchmark what is achieved in each area. By examining Swedish studies in the two areas, a benchmarking of the activities in Swedish companies so far has also been an aim.

The scope was set to find the most established "truths" and to collect references to good information sources to make it possible for the reader to easily continue reading about knowledge management and organizational learning.

3.1.2 Method

The method has been to try to find literature studies in the two areas performed by others. Different literature studies pointing at the same definitions, important actors and foundation work as being most important will give a high probability that it is actually the agreed definitions and the most important actors and work.

3.2 Results Organizational Learning

3.2.1 Definitions

Organizational learning is commonly defined as a characteristic of an adaptive organisation, i.e., an organization that is able to sense changes in signals from its environment (both internal and external) and adapt accordingly[12]. More specific definitions of organizational learning differ depending on if the writers emphasize organizational learning as a technical or a social process. The Swedish term corresponding to organizational learning is "organisatoriskt lärande".

3.2.1.1 Organizational learning as a technical process

The technical view assumes that organizational learning is about the effective processing, interpretation of, and response to, information both inside and outside the organization. This information may be quantitative or qualitative, but is generally explicit and in the public domain.

3.2.1.2 Organizational learning as a social process

The social perspective on organization learning focuses on the way people make sense of their experiences at work. These experiences may derive from explicit sources such as financial information, or they may be derived from tacit sources, such as the 'feel' that s skilled craftsperson has, or the intuition possessed by a skilled strategist. From this view, learning is something that can emerge from social interactions, normally in the natural

[12] From http://en.wikipedia.org/

work setting. In the case of explicit information it involves a joint process of making sense of data. The more tacit and 'embodied' forms of learning involve situated practices, observation and emulation of skilled practitioners and socialization into a community of practice.

3.2.2 Important actors

Chris Argyris and Peter Senge are two well referenced actors in organizational learning[13]. A classic expression of the technical view can be found in the work of Argyris and Schön on single- and double-loop learning[14, 15]. Lave and Wenger[16] provided an example of the social perspective in action in their studies of apprenticeship and communities of practice. Donald Schön[17] also provides some insights into the use of 'tacit' sources in his exploration of reflective practice (compare with 3.3.3.1). Those operating within the social perspective may view organizational learning as a social construction, as a political process, and/or as a cultural artifact[18]. Magnus Söderström is mentioned as an important actor in Sweden[19].

3.2.3 Available knowledge

3.2.3.1 The Fifth Discipline

Peter Senge's book *The Fifth Discipline*[20] is an introduction to the basics and uses of organizational learning. Senge also argues that rather simplistic frameworks are applied to what are complex systems. Thus, the argument runs, a better appreciation of systems will lead to more appropriate action.

3.2.3.2 Society for Organizational Learning

The Society for Organizational Learning (SoL)[21] was founded in 1997 by Peter Senge (see above). It was founded as the successor to the former Center for Organizational Learning at Massachusetts Institute of Technology (MIT).

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[13] The encyclopaedia of informal education: http://www.infed.org/encyclopaedia_index.htm#o
[14] Argyris, C., & Schön, D. (1978) *Organizational learning: A theory of action perspective*, Reading, Mass: Addison Wesley.
[15] Argyris, C. and Schön, D. (1996) *Organizational learning II: Theory, method and practice*, Reading, Mass: Addison Wesley.
[16] Lave, J., & Wenger, E. (1991) *Situated learning: Legitimate peripheral participation*, Cambridge: Cambridge University Press.
[17] Schön, D. A. (1983) *The Reflective Practitioner. How professionals think in action*, London: Temple Smith.
[18] Easterby-Smith, M. and Araujo, L. 'Current debates and opportunities' in M. Easterby-Smith, L. Araujo and J. Burgoyne (eds.) *Organizational Learning and the Learning Organization*, London: Sage.
[19] Söderström, M (1996) *Hur lär organisationer? - en diskussion om det organisatoriska lärandets nyckelfrågor.* Solna: Arbetslivsinstitutet
[20] Senge, P. *et. al.* (1994) *The Fifth Discipline Fieldbook: Strategies and Tools for Building a Learning Organization*
[21] Society for Organizational Learning, viewed at: http://www.solonline.org/

3.3 Results Knowledge Management

3.3.1 Definition

Knowledge Management (KM) is commonly defined as "the management of activities and processes for leveraging knowledge to enhance competitiveness through better use and creation of individual and collective knowledge resources"[22]. Knowledge Management is any process which incorporates the desire to expand our range of inquiry with the need to simplify our decisions. This can involve both human and technological applications which help create, organize or share knowledge[23]. The Swedish term corresponding to knowledge management is "kunskapshantering".

3.3.2 Important actors

Three publications that includes literature studies about the area of knowledge management were gone through[24, 25, 26]. They mention Michael Polanyi, Thomas Davenport and Ikujiro Nonaka as influential persons in the area. Mats Alvesson[27] is mentioned as an influential person in Sweden in two of the publications.

Another researcher in the area, Chun Wei Choo, searched the Social Science Citation Index database in order to identify influential works on knowledge management. The five most frequently cited authors and cited references were as follows:[28]

RANK No.	Items	Cited Author
1	197	NONAKA IKUJIRO
2	111	DAVENPORT THOMAS
3	76	POLANYI MICHAEL
4	67	BROWN JOHN SEELY
5	62	LEONARD-BARTON DOROTHY

RANK No.	Items	Cited Reference
1	126	NONAKA I, 1995, KNOWLEDGE CREATING COMPANY
2	48	NONAKA I, 1994, V5, P14, ORGANIZATION SCIENCE
3	43	DAVENPORT TH, 1998, WORKING KNOWLEDGE
4	39	LEONARDBARTON D, 1995, WELLSPRINGS OF KNOWLEDGE
5	39	POLANYI M, 1966, TACIT DIMENSION

Table 2. Search results from the Social Science Citation Index database.

[22] CWA 14924-1, European Guide to good Practice in Knowledge Management - Part 1: Knowledge Management Framework
[23] From http://en.wikipedia.org/
[24] Bäcklund, Louise. (2002), Knowledge Management - Företagskulturens och teknologins betydelse för kunskapshantering, Göteborg, Department of Informatics
[25] Jörgen Stridh and Alexander Wojdas (1999), Kunskapshantering - Hur ledningen kan motivera till kunskapsspridning, Kandidatuppsats, 10 poäng, Stockholms Universitet, Företagsekonomiska institutionen, Högskolan på Gotland
[26] Niclas Gerdin and Henrik Svensson (2000), Kunskapsöverföring mellan Projektledare, Magisteruppsats, 20 poäng, Högskolan i Halmstad, Institutionen för Teknik och Naturvetenskap, Industriell Organisation och Ekonomi
[27] Alvesson, M., Ledning av kunskapsföretag, Norstedts, Kristianstad, 1992.
[28] Chun Wei Choo, Perspectives on Managing Knowledge in Organizations, Cataloging & Classification Quarterly, Volume: 37 Issue: ½, ISSN: 0163-9374 Pub Date: 1/20/2004

Among other influential actors can be mentioned Verna Allee, who has made a set of 12 principles for knowledge management[29]. She has also defined principles for a knowledge management system (KMS) built up by the organizational information technology infrastructure and the organizational culture. Henning Bang[30], Bengt Persson[31] and Mats Engwall[32] are Swedish researchers that have made important contributions to the area.

3.3.3 Available knowledge

3.3.3.1 Theory

Michael Polanyi was the first to express that ”We can know more than we can tell” and coined the term “tacit knowledge”[33] (compare with 3.2.2). The knowledge that can be expressed in words and figures is only the “top of the iceberg” of the entire body of knowledge in an organization according to Ikujiro Nonaka[34]. This can be a problem according to Thomas Stewart[35], because tacit knowledge is difficult to change and convey, and errors are made without people being aware of it.

There are many different theories of how to create an environment that encourages to knowledge exchange.

According to work with knowledge management at the European Committee for Standardization (CEN), the five core knowledge activities are[36]:

a) **Identify knowledge:** People and organizations are encouraged to think about what they want to achieve and the knowledge that is required to make it happen. The identification of existing knowledge is essential for supporting decision taking.
b) **Create (new) knowledge:** There are many ways to create new knowledge. At the personal and team level, it is often as a result of social interaction, i.e. through training, learning by doing, joint problem solving or brainstorming.
c) **Store knowledge:** In order to build up knowledge assets (so-called “knowledge capital” and “knowledge bases”), knowledge needs to be embedded within an organization. Much knowledge is ‘stored’ in people’s brains and will often remain there as so-called “tacit knowledge”. Furthermore, knowledge can be ‘stored’ in team or organizational routines, without even having been explicitly described (e.g. as s successful sports teams show us). As long as such people and teams remain accessible, one can say that their knowledge is “memorized” by the organization and available for (re)use.

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[29] Allee, V, Training and Development. ”12 Principles of Knowledge management” Vol. 51, No 11, 1997.
[30] Bang, H, Organisationskultur. Studentlitteratur, Lund, 1994.
[31] Persson, Bengt (1997): Kunskapsöverföring till yrkesverksamma inom landskapsarkitekternas arbetsfält, Institutionen för landskapsplanering, Alnarp.
[32] Engwall, Mats (1995): ”Jakten på det effektiva projektet”, Nerenius & Santérus Förlag AB, Stockholm.
[33] Polanyi, M, The Tacit Dimension, Routledge & Kegan Paul Ltd, London 1966.
[34] Nonaka, I, The knowledge-creating company: how Japanese companies create the dynamics of innovation. Oxford University Press, New York, 1995.
[35] Stewart, T, Intellectual Capital; the new wealth of organisations. Doubleday/Currency, New York, 1997.
[36] CWA 14924-1, European Guide to good Practice in Knowledge Management - Part 1: Knowledge Management Framework

d) **Share knowledge:** The aim of this step is to transfer knowledge to the right place, at the right time, with the right quality. This means that the knowledge arrives in the right context - i.e. where value is created. Sharing can take place in many ways. Knowledge can be added to databases or distributed via documents. This is the so-called “stock approach”: people make knowledge available in such a way that other people can find it. But most knowledge can best be transferred from one person to another by direct interaction via collaboration, workshops, coaching, apprenticeships etc. This transfer of knowledge directly between people can be called the “flow approach”. Methods and tools that support the sharing of knowledge include: e.g. intranets/portals, databases, collaboration, job rotation, coaching, seminars, and training.
e) **Use knowledge:** “If only we knew what we know…we would be three times more profitable!” Knowledge can only add value when it is being used in an organization.

Thomas Davenport and Laurence Prusak wrote one of the most referenced publications about knowledge management (see 3.3.2) called *Working Knowledge: how organisations manage what they know* [37]. They develop a concept of internal knowledge "markets" in companies, and that the dynamics of this market must be understood in order to increase the flow of knowledge and enable efficient use. Impediments to market success can then be identified, e.g. people not feeling that they are getting any return from sharing knowledge, buyers and sellers not knowing of each other's existence, and so forth.

Bengt Persson has described the exchange of knowledge as depending on the level of interaction. A low interaction level, e.g. dissemination of knowledge in booklets and documents will have high capacity (can be spread to many people) but low efficiency (low exchange of knowledge). The opposite is e.g. personal communication[38].

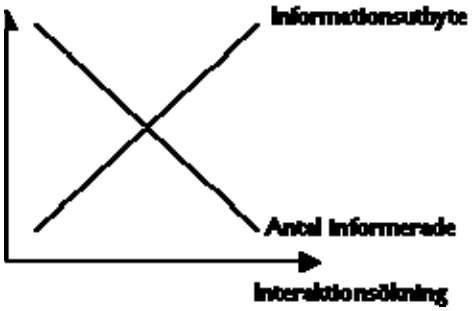

Figure 4. Capacity and efficiency of knowledge exchange as a function of the interaction level (in Swedish), Bengt Persson (1997).

[37] Davenport T,H, och Prusak L, Working Knowledge: how organisations manage what they know. Harvard Business School, Boston, 1998.
[38] Persson, Bengt (1997): Kunskapsöverföring till yrkesverksamma inom landskapsarkitekternas arbetsfält, Institutionen för landskapsplanering, Alnarp.

3.3.3.2 CEN Workshop Agreements

The European Committee for Standardization (CEN) has produced a CWA (CEN Workshop Agreements) for knowledge management[39]. CWAs are consensus-based specifications, drawn up in an open Workshop environment. The CWA for knowledge management (KM) aims to provide European readers with a practical introduction to mainstream thinking in KM and give an indication of some of the emerging new thinking in KM.

The CWA for knowledge management is divided in 5 parts:

- Part 1: Knowledge Management Framework
- Part 2: Organizational Culture
- Part 3: SME Implementation
- Part 4: Guidelines for Measuring KM
- Part 5: KM Terminology

3.3.3.3 Ennoble

A free course in knowledge management (in Swedish) is available at the Ennoble website[40]. The course teaches the theoretical background referenced in the master thesis by Niclas Gerdin and Henrik Svensson at Högskolan i Halmstad, which is one of the literature studies referred to above.

3.3.3.4 Knowledge Management Consortium International

KMCI[41] was founded in 1997 as an international professional association of Knowledge Management practitioners. They offer e.g. Certificate Programs in knowledge management.

[39] Available at: http://www.cenorm.be/cenorm/businessdomains/businessdomains/isss/cwa/knowledge+management.asp
[40] http://www.ennoble.se/kunskap.html
[41] http://www.kmci.org/

4 Systemized management of environmental knowledge and information

A first sketch of such a systemized management of environmental knowledge and information would look like is drawn in figure 4. By viewing the management of environmental knowledge and information from the system perspective, reflections can be drawn, the elements of repetitive kind can be identified, and some of the inefficiencies in the information system might be mended.

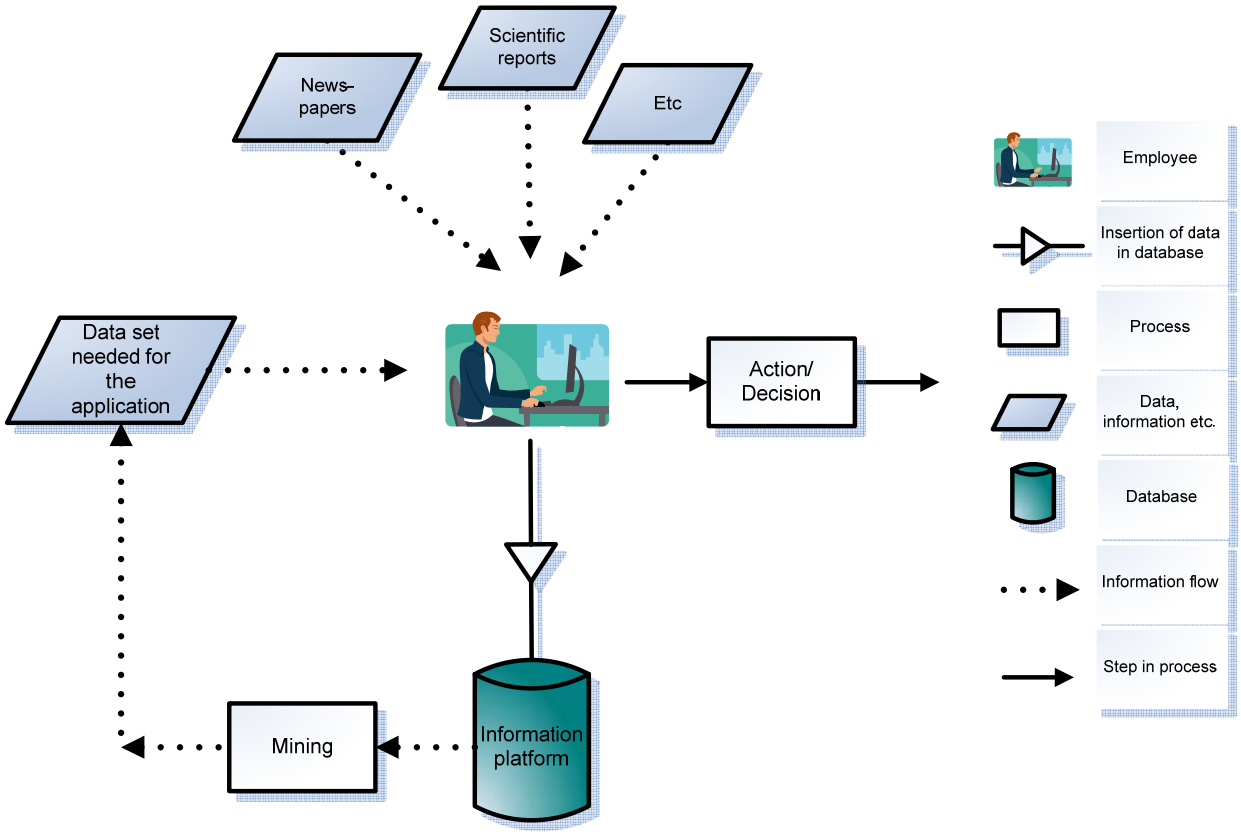

Figure 5. Draft sketch of a system for management of environmental knowledge and information.

The employee has access to environmental information in the form of external data sources like newspapers, scientific reports etc. and internal data sources like documents, databases, intranets etc. The employee uses his or hers competence to improve the environmental performance of the organization and accomplishes new knowledge and experience that can be documented to be reusable at another time or place in the company. A “mining” function provides the employee with the information that is relevant for the work task in question from the general information system where all information is stored.

5 Analysis and conclusions

The framework for the methodology has been built on organizational learning and knowledge management. These two areas apply for both individuals and the organization they are part of. Both man and system are hence given deeper awareness of what they are part of, enabling and encouraging the employees to make observations and reflections and strive to learn and improve.

The benefits of a structured way to manage knowledge and information in an organization are several. For the elements of repetitive kind, routines can be created and the focus of the environmental work can be transferred to the areas where more development is needed. Such areas can be interpretations of environmental information adapted to the user of the information or detailed studies of e.g. upstream and downstream effects of environmental measures, local environmental impact etc.

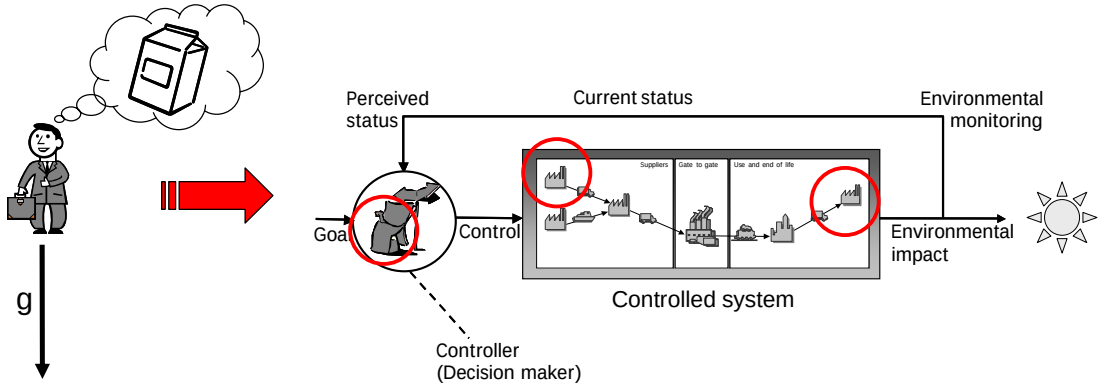

Figure 6. This allegorical picture illustrates a person going to the shop to buy milk. The gravitation is of higher importance to him than the task of buying milk but as it is a constantly occurring phenomenon the person needs not take care to it. This conception can be applied also in the environmental information area, to be able to create satisfying routines for the repetitive tasks and put more resources on the tasks that need to be developed further.

One conclusion that has been made so far is that the extent to which companies, parts in a company or applications of environmental work have a structure for the knowledge and information management is varying. In some organizations or applications, there can be found improvement potentials such as confusions, inefficiencies and inconsistencies. A system like the one described in chapter 4 can be created for management of knowledge and information based on experiences to accomplish the improvements. However, it may be more or less valuable at different scales to implement this methodology in relation to the cost to maintain it.