

## Institutional and communicative processes constituting specific technology paths and environmental perceptions

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Ole Erik Hansen\*<sup>1</sup>, Bent Søndergård\*<sup>2</sup>,  
Jesper Holm\*<sup>2</sup> and Søren Kerndrup\*\*

\*<sup>1,2</sup> Department of Environment, Technology and Social Studies, Roskilde University, Denmark

\*<sup>1</sup> Address: POB 260, DK-4000

Roskilde, Denmark

fon: +45 4674 2122

e-mail: oeh@ruc.dk

\*\* Department of Development and Planning, Aalborg University, Denmark

### Abstract

*Building on knowledge management discussions, the paper discusses how environmental knowledge are created and communicated in enterprises and sectors, taking communication on environmental properties of chemical in industrial production as a case. Knowledge is conceived as situated enacted practice making the task of environmental communication a problem of transfer and translation of knowledge between different practice communities and knowledge systems, each having specific bounded cognition.*

*Taking this theoretical approach, the paper, as an example, analyses specific problems related to the development and implementation of a science based information system to assess and document environmental properties of chemicals (The "KEMI-centre project"). The paper discusses how knowledge systems and practice communities condition environmental communication on chemicals and*

*environmental performance within and between enterprises/organisations.*

### Introduction

The scope and depth of environmental change processes have expanded. Environmental changes in most cases have to be conceived as systemic, involving a broad array of actors; the task to handle environmental issues now pervades every level and functional unit of enterprises and product systems. Speaking generally, environmental management and planning has turned into a polycentric activity, taking place in settings of knowledge and capabilities dispersed on many actors. Environmental knowledge creation is dispersed and environmental information and knowledge have to be transmitted, processed and acted on within a broad array of organisations and actor configurations. This makes the processes of environmental knowledge creation and transfer, within and between such settings, a central issue.

Environmental communication processes not only is a question of passing information, but also a constitutive process; specific knowledge systems, actor coalitions and cognitive structures are co-produced in these communicative processes. Environmental information and knowledge are subject to selection and strategic interpretation, and specific paths and 'innovation systems' evolves as the result of the communication processes.

Taking this as a point of departure, the paper examines in depth the problem of creation and transfer of environmental knowledge. In this endeavour we build on knowledge management discussions, in particular how knowledge relates to practice and knowledge systems (part I). Based on this understanding, the paper analyses a specific case on communication on environmental properties of chemicals in industrial production (part II).

## Environmental communication of enterprises

Environmental communication has been given growing attention within business management. However, the dominating approaches have been 'traditional' in terms of the scope of means: relational marketing in business-to-business, target group analysis, stakeholder management, etc. Often the analyses are translated into operational communication tools on how enterprises most efficiently could promote their environmental messages (e.g. Valeur and Tinge, 2001). Another line of development has been environmental reporting and benchmarking (e.g. Wheeler and Elkington, 2001). Strategic approaches have been present, but somehow basic problems of how common cognitive structures with sectors and production chains (enabling interactive communication) evolve and are subject to strategic behaviour are 'under-represented'.

Important research exceptions however, do exist. Heiskanen *et al.* (1998) in their research on product change exposed how absence of shared goals and priorities in the product chain formed major barriers to exchange of environmental information. They gave emphasis to the need of shaping shared environmental reference systems in product chains, and development of roles, capabilities and competencies of chain actors. Clarke and Roome (1999) in a microanalysis demonstrated how environmental relations of enterprises served as learning-action network, in which the enterprises developed specific environmental perceptions through complex processes of negotiating, learning, action and change together with their stakeholders.

In parallel, work on environmental innovations (Hansen *et al.*, 2002, Søndergård *et al.*, 2001) has pointed to how specific institutional arrangements and distributed innovative green capabilities evolves in sectors and industries and shape the way environmental problems and horizons

of solutions are communicated. This finding is in many ways similar to findings in studies on greening of networks (e.g. Boons, 1998).

This body of research points to the need to understand the dynamic interaction between organisations in networks and production chains, in particular how possibilities and limitation for the generation and transfer of environmental knowledge are shaped as a result of the interaction.

The question is not how enterprises most efficiently organise their environmental communication, but how the objects of environmental change are construed. This involves an understanding of the more basic question how environmental knowledge is shaped and how meaning on environment is produced and organised in the (environmental) communication processes of enterprises, product chains, and production systems.

## Part I: Knowledge creation and transformation within and between communities of practice and networks of practice

One way, but not the only, to deepen this understanding of the dynamic processes of greening is to focus on creation and transfer of knowledge of environment and greening as interactive processes within and between firms. By understanding *knowledge as situated enacted practice processes*, it is possible to identify the underlying dynamics of knowledge as communicative processes within and between *fields of situated practice*; the flow of knowledge is enacted through the translation of knowledge between similar and dissimilar fields of practice.

### Environmental knowledge as situated enacted practice

The conception of 'knowledge' is complex and endowed with ambiguity - and this becomes even more the case when it is discussed in an environmental setting. A short look at the knowledge management tradition displays some of the complex ontological and epistemological differences:

- The discussion between information and knowledge perspective, which has been seen in the differences between Simon/March, and Nonaka explicated in Nonaka (1994)
- The discussion between the cognitive and the praxis approach which is explicated in Ryle (1949)
- The discussion between individual and collective knowledge, which is explicated in the Argyris and Schön (1996)
- The discussion of knowledge as stock or relational, which is explicated in Stacey (2001).

From our theoretical and empirical analyses it has proved to be useful to understand *knowledge as situated enacted practice*, where the main constitutive element is how people through practice continuously create and recreate knowledge and how they establish their capabilities over time, within and between contexts. With this focus on *practice context*, we may overcome the traditional problems mentioned above; ontological and epistemological differences still exist, but we see the practice concept as a way to integrate and overcome some of the artificial split between the different positions.

In order to unfold the implications of this knowledge concept, it can be useful to look at the key elements in the definition.

- By knowledge as *practice* we want to emphasise that knowledge is connected to practice in term of 'know how'. When we ask to the environmental knowledge of people or industrial actors, we do not ask if they can cite the environmental encyclopedia, but if they

are able to use the knowledge of environment to green their activities. Furthermore, in understanding knowledge as practice we highlight that the tacit and explicit dimensions of knowledge are integrated and cannot be understood separately.

- By knowledge as *situated* we want to emphasise that knowledge is embedded and embodied in a specific material and social settings. This social and material embeddedness of knowledge emphasises that knowledge is not going to be seen as neither individual nor collective, but as relational enacted in the interaction between individuals and collectives in a social context. (Weick, 1995, 2001, Stacey, 2001). The notion of material embodied knowledge underlines the role of materials/technologies as actants in the knowledge creation process, where the materials play an active role in the enactment process as suggested by the actor-network theory (Latour, 1987, 2001, Callon, 1987).
- By knowledge as *enacted* we want to focus on how knowledge is enacted as a sensemaking process, where sensemaking of actors are enacted through communicative practice. A practice, where knowing is often retrospective and is enacted by creating histories in order to make sense in (a chaotic) fields of practice; histories, where the medium of the stories often will be very closely connected to the specific social and material settings.

Knowledge as situated, enacted practice has important consequences for understanding knowledge generation and transfer within and between organisations, production chains and networks. It establishes a perspective that opens up for new ways of perceiving communicative processes.

A major distinction is connected to the understanding of the *fields of situated enacted practice* as the locus for making sense of practice and knowledge. It generates a row of new questions. How is possible to understand the dynamic and complex process of knowledge creation and transfer in a practice perspective, given the situa-

tion that knowledge is located to different activities, actors, actants and relations within and between organisations, production chains and network? How is it possible to develop environmental knowledge in different fields of practice and to transfer this knowledge across different fields of practice?

In order to answer these questions we have first of all to discuss:

- How knowledge as situated practice is dispersed on different fields of practice
- How knowledge is transferred between different situated practice fields.

And second to discuss

- What knowledge as distributed practice means for communication within and across different fields of practice.

### Knowledge as distributed fields of practice.

The complexity and ambiguity of knowledge is not only related to its different forms as tacit/explicit, individual/organisational, but is also related to the way knowledge is distributed in the society on different activities, actors, actants, and relations and over time. A discussion which have been raised by the Austrian school in economic writings of Hayek (1938, 1945), Loasby (1999) and in sociological writings of Schutz (1952), the philosophical writings of Hayek (1978), Ryle (1949) and in management writings by Tsoukas (1986, 2001). The ontological and epistemological complexity and ambiguity of knowledge is **related** to the continuous enactment by the communicative processes within and between the different fields of situated practice.

By emphasising situated practice as the locus of knowledge development, knowledge is no longer seen as connected to individuals as subjects, but as a social category (Wittgenstein, 1958). The *communicative acts in fields of practice* are seen as the 'subject' of enactment of knowledge. Knowledge creation and transfer is developed within and

across the different fields of practice. These fields of practice have been described as communities of practice by Constant (1987), Lave and Wenger (1991) and Brown and Duguid (1991) and further developed by Brown and Duguid (1998, 2001) and Wenger *et al.* (1998, 2000, 2002).

Common for these contributions, is a focus on knowledge as situated, enacted practice with special emphasis on how common practice generates sense in a community. However, some differences, related to the interpretation of the concept, have to be noted. Wenger *et al.* seem to focus on the community aspect e.g. shared meaning, while Brown and Duguid focus more on practice as the central element.

### Communities of practice

Communities of practice evolve from the common practice of the day-to-day activities, where people make sense of what they do, how they do it, and why they do it. Tight couplings of the day-to-day practice often go with an interrelation of the day-to-day practice and communicative acts (mainly based on face-to-face interaction). Sensemaking is a complicated interaction process where sense is enacted by a continuously process of story telling. The paradigmatic case of sensemaking processes in situated practice is Julian Orr's study: 'Talking about Machines' (1996). In environmental context, Fischer and Rosdahl (2001) have given excellent examples on sensemaking processes among sales peoples in a printing firm.

Making sense in communities of practice does not mean that people have the same meaning, but should more be seen as a grammar e.g. a way that makes sense of experience, information and knowledge in a social and material setting.

Knowledge is conceived as institutionalised practice (Kerndrup *et al.* 2002b). This also implies that sensemaking processes are seen as an en-

actment process where practice and knowledge are continuously enacted through communicative and material practices and in this way can be understood as a *path creation process*. This means that we see the enactment process as different from the way knowledge sociology try to reflect on path dependency as a process of stabilising and closure.

### Networks of practice

Networks of practice are loose couplings of people working with the same type of practice in different settings, while their day-to-day practice are not connected. It can be links between people in different environmental communities in different production sites (e.g. environmental professionals in different enterprises) or environmental communities in different organisations. The same type of practice creates a frame of sensemaking that direct sensemaking by developing the same type of procedures (grammar) for enactment, selection and retention of data, information and knowledge (e.g. reference to the same scientific methodology in environmental documentation) despite differences in social and material settings.

Central are the differences in the sensemaking processes, where sensemaking within communities of practice is enacted by the use of a common knowledge of a joint situated practice and sensemaking within networks of practice is enacted by common practice in different settings.

### Communication across practice fields

In this understanding, the dynamics of knowledge generation and transfer are constituted through communicative practices within different fields of practice. Tight and loose couplings in communities and network form a structured setting in which knowledge creation and transfer take place. A setting with locale fields-situated sensemaking, which both becomes a source of

new knowledge creation and an obstacle to communicate and have a flow of knowledge.

Transfer across different fields of practice is conditioned by these differences in sensemaking. The differences make the process of knowledge creation and transfer a complex and ambiguous process, where flows of knowledge are enacted through *translation* of knowledge between similar and dissimilar fields of practice. Knowledge is created and re-created through institutional processes both within and between different fields of situated practice. In the next section we will examine such processes of translation and transfer of knowledge across situated fields of practices in relation to organisations, production chains and networks.

### Communicative practices: Creation and transfer of Knowledge in organisation, production chains and networks

The conception of knowledge as situated enacted practice has important consequences for our way to understand the dynamic of knowledge creation and transfer within and between organisations in production chains and networks. It breaks with the mainstream view of organisations as homogeneous knowledge creating entities, and knowledge transfer/communicative processes as simple unequivocal processes. And replaces it with a framework where organisations within production chains and networks are seen as a complex and ambiguous institutional settings of autonomous and overlapping communities and networks of practice.

### Organisation as a constellation of situated practice

Organisation as a constellation of situated practice has many roots in organisational theory: Organisational culture (Schein, 1992), decision-making (March and Simon, 1958, Cyert and March, 1992, March, 1994, 2000), evolutionary

economics (Nelson and Winter, 1982), and sensemaking (Weick 1979, 1995, 2001).

In particular knowledge theory (Wenger 1998, Wenger and Snyder 1998, Brown and Duguid 1998, 2000, 2001) has discussed organisations and communities of practice. Wenger and Snyder (1998) argue that the communities of practice are very different from such organisational structures as formal work groups, project teams and informal networks, because communities are enacted in a common practice, where membership is making sense for the individuals. This means that communities of practice are autonomous emerging entities within and between organisational settings. Therefore, communities of practice cannot be designed or directed from above as task groups, departments, etc, but is developed from below. And as such, creating social and material 'space' for community activities is the only way to support them.

Seeing organisations as constellations of different communities of practice (Brown and Duguid, 1999, 2001) is a way to understand how different kind of knowledge is created within organisations, and thereby understand the difficulties with transfer of knowledge within the firm. Cognitive distance and absorptive capacity here become central notions.

Different kinds of practice mean that knowledge has to be translated from one field of situated practice to another field. The *cognitive distance* between the different fields of practice is important for understanding the difficulties by translating the knowledge (Nooteboom, 2000). Cognitive distances between communities of research, communities of production, communities of sale can be substantial and explain many of the failures in firms of making sense of knowledge.

- When information does not make sense, there will be no attention to the information in the community and/or the information will not be part of the day-to-day practice as many examples show. Environmental inno-

vations developed in one communities of practice (for example options of new products, materials, technologies, or behaviour) will not be used because it does not get attention from other communities of practice.

- Or if the information makes sense, it may differ very much from the way it gives sense to the other communities of practice in the organisation. A problem, which is often seen in relation to problem solving, related to environmental effects of processes and products. Communities of environmental professionals may see the problem in relation to reducing the eco-effect and mostly focus on ways to de-couple the environmental effects from the processes and products. Communities of production, on the other hand, see the environmental effects in relation to the productivity and planning, while the communities of sales and marketing see the environmental problem in relation to how sale can be optimised.

Another barrier is the *absorptive capacity*, which can be ascribed to organisational units or enterprises (Cohen and Levinthal, 1990). Absorptive capacity in enterprises is determined by tight and loose couplings of practice in communities and networks (Orlikowski, 2002).

Cognitive distance and specific absorptive capacity explicate difficulties of knowledge transfer between practice communities.

As indicated above, communicative practice *within and across situated fields of practice* enact the sensemaking processes of knowledge and information. Communicative practices can be seen as (organisational) sensemaking, knowledge creation and decision making processes (Choo, 2001) taking place in and between fields of practice. These processes can be complex responsive processes (Stacey, 2001) made up by *communicative acts* within and between communities of practice.

The problem to establish *communicative practices* will differ. The possibility to handle complex and ambiguous information and knowledge is high

inside communities of practice due to a shared cognition based on the enacting, selection and retention of knowledge. Communicative acts across fields of practice are more complicated. Establishing communicative practices rely on the ability to develop a common frame to translate complex and ambiguous information and knowledge in a way that makes sense between the different fields of practice.

Stories in organisations are often seen as a way to enact frames within and between different fields of practice. Use of codified knowledge is another way to make knowledge transferable within and between fields of practice.

Codified information systems is seen as ways to make the transfer of knowledge within and between different kinds of practice easier by bringing knowledge on a form where it is easy to transfer and store by codification. The codification process is important to make the knowledge transferable, but the trade off is, that it reduces the complexity and ambiguity of the information and knowledge, with the result that the situated practice is abstracted away. The main problem is to develop systems, which support the practice, instead of developing systems, which are counterproductive in relation to the existing practice. In order to do that, it is important to design the system from a practice point of view. The challenge is how companies can substitute databases systems with more interactive systems, which reflect the situated practice and enable shared knowledge.

### **Production chains and networks as constellations of practice**

Production chains and networks can be seen as constellations of tight and loose couplings of practices, where, as stated above, tightness and looseness of coupling are connected to the similarities and dissimilarities of practice. This perception of actor-relation in chains and network diverge from mainstream use of production

chains related to flow of materials or networks related to social connections. To some extent it relates to the 'Uppsala school', which emphasises the relations mediated by activities, resources and actors, and the actor-network theories that emphasise the problem of knowledge translation.

### **Production chains**

The *configuration of production chains* is mainly seen as activity chains related to flows of materials. The specific configuration construes a distribution of capabilities related to the activities (activity fields) undertaken in the specific chain, a distribution, which in turn conditions how chain actors can practice in the activity fields and can connect to these fields. (This approach of capabilities was first developed by Richardson (1972) and further developed by Loasby (1999).) The understanding of *capabilities as fields of practice*, together with the concept of *absorptive capacity* and *cognitive distance*, provide a conceptualisation of the division of knowledge and the way knowledge are developed and transferred within and between chain actors (Kerndrup *et al.* 2002b). Communicative acts within product chains and networks take place in and co-shape a setting of distributed capabilities.

Environmental problems are related to activities across the production chain, but the knowledge, which is involved to overcome the problems, is related to the separate fields of capabilities. It is the similarities and complementarities between the different fields of capabilities that are important for the possibility to develop and translate knowledge within and between the different parts of the production chain.

Experiences from environmental innovations in production chains show that innovative solutions often are developed by communicative acts between similar and complementary fields of practice (Kerndrup *et al.*, 2002b).

Development and transfer of knowledge is also connected to the practice field's position along the production chain. The cognitive distance and differences in the absorptive capacity are often lesser between communities and networks of practice in the same stage of production - a knowledge that intuitively is used in "ERFA groups" (Danish institutions: industry organised exchange of experiences within functional areas, e.g. quality management). It can be more difficult to make sense across stages in the production cycle, due to the disparity of communities of practice. For example: knowledge practice in knowledge intensive chemical firms, seen as a cognitive culture, is very far away from the knowledge practice in small Danish textile firms (Kerndrup *et al.*, 2002b).

### Networks/stakeholders

The configurations of stakeholders outside the production represent a more heterogeneous group of practices. Their connection to production activities can be direct and/or indirect, and their fields of practice include a broad variety of practices. A variety that makes sensemaking and shaping of communicative processes very complex and ambiguous, why we only try to indicate these processes by focusing on a few key configurations.

- Research and development practices
- Regulatory practices

The research and development practice is related to the national and regional systems of innovation, which play an important role for development practice in industries, given its support to development of new knowledge, new technologies and new organisations. The research and development system represents modes of practice that is both similar and dissimilar to the R&D practice in production chains.

The cognitive distance between these institutions varies in relation to the different practice

forms in the industry and research, showing that firms often need to have research practice in order to benefit of and absorb knowledge from these institutions. This is also the reason for the many forms of transfer activities in the area. Knowledge developed in the research system reflects the scientific practice and has to be translated to practice in the production chain, which can be very difficult.

In this interactive process, however, specific *knowledge systems* emerge as coalitions of actors, specific configurations of actors, relations and perception of problems and solutions. This introduces additional problems of the transfer of knowledge across different knowledge systems and of chain actors, which may subscribe to a number (often disagreeing) knowledge system. The existence of such different knowledge systems in relation to the environmental communication of enterprises represents a specific problem (Kerndrup *et al.*, 2002a), see below: *Cases of practice*.

The regulatory practice is related to the regulation of the environment and is founded in a practice very different from the business practice. Studies have shown that it is difficult to translate regulatory practice to business practice.

In looking at regulation as communicative acts, regulation is regarded also as knowledge and learning process (Clayton *et al.*, 1999, v. Dijken, 1999, Søndergård *et al.*, 2001, Hansen *et al.*, 2001), a perspective that is not reflected in the traditional dichotomy between command-control and market based regulations. In the change towards proactive regulatory strategies, the scope of communicative regulatory acts expands and takes new institutional forms (Søndergård *et al.*, 2001) – and in parallel the environmental communicative acts of enterprises have changed.

Traditionally the regulatory practice in public authorities is related to environmental departments in firms. The main function of these de-

partments had up to 1990 mainly been to decouple the environmental demands from the other kind of practice in the firms. As a consequence of the growing focus on environmental problems from stakeholder, both within the production chain and from other stakeholders, the flow of information and knowledge has become much more complex and ambiguous, resulting in a complicated interaction between activities, actors, actants and relations over time. Scope of environmental activities and practices in enterprises has been expanded. As a result, environmental management units find themselves involved simultaneously in a number of different knowledge systems (see part II, *Cases of practice*).

### Communicative practices

The problem of transfer of knowledge across situated fields of practice in organisations, chains and networks have to be studied in specific context. We have to identify communicative practices on transfer of knowledge, follow how these practices evolve, turn into conventions and norms, and eventually are institutionalised.

The study of exchange of knowledge and information on environmental properties of chemicals, which is going to be discussed in the next part, provides some examples on how such practices may evolve and be turned into institutions structuring the transfer of knowledge across fields of practice.

## Part II: Enterprises: Environmental Communication on chemicals

Enterprises' environmental communication on chemicals represents a specific case of knowledge formation and exchange. We are going to examine this case with the objective to

- unfold and specify the theoretical approach by an analysis of a specific field of knowledge creation and communication.

- address environmental management and planning on dynamics and obstacles of environmental knowledge creation and communication on chemicals.

The analytic material presented below has been elaborated as part of a research project on the developmental and implementation of an "expert system" on environmental documentation of chemicals within the KEMI-centre project<sup>1</sup>. The development of the "expert system" and the implementation is still ongoing, for this reason no specific analyses of the tool or implementation in the individual enterprises can be presented. What are presented are problems and options related to the specific problem of installing chemical information systems or expert systems in enterprises and chains, which were identified during the initial stages of analysis.

### The specific project: Objectives and challenges of the KEMI-centre

The 'KEMI-Centre project' is a co-operation of enterprises, research institutes and universities established with the objective to develop an IT-based tool to document and communicate environmental properties of industrial chemicals. The Danish research institutes, DHI Water and Environment and DTC Danish Toxicology Centre, undertake the development of the tool/information system. The basic structure of the IT-based tool is a core database of scientific data on the chemicals, with a number of specific application tools on top of it. These application tools, as well as the specification of the system, are to be developed in pilot set-ups in the participating enterprises.

This developmental work can be seen as a (strategic) response to an anticipated demand of environmental competencies of enterprises to meet future requirements in business chains and regulation. Specific examples of such expectations can be:

- New demands on the market to be able to provide specific environmental documentation; e.g. for EMAS certified customers, fulfilment of demands within certified environmental labels systems or public procurement frameworks.
- New business strategies based on servicing and partnerships demanding environmental competencies of e.g. chemical suppliers
- Anticipated new EU regulatory frameworks introducing extended producer and downstream responsibility.

It can also be seen as a response to the need of having tools, which can support a number of internal and external operational tasks, in particular communicative tasks. The specific intended use of the system ranges from expert system options (generation of LCA-data, environmental classification related to design or purchase), use as a system of knowledge sharing in the organisation and a system to support external communication.

This indicates that such tools/information systems have to be considered in relation to a wide number of practices and communities of practice. This represents the basic challenge of an implementation of such systems in industrial and social settings.

### Environmental communication on chemicals as communicative practices

Documenting and communicating environmental properties of chemicals within organisations and across actors of product chains and networks could be perceived as a 'simple task' of providing and codifying scientific knowledge. The problem is, however, that the 'eco-complexity' of environmental impacts of chemicals makes it impossible to obtain such a body of scientific knowledge. We face both operational uncertainty (lack of data) and conceptual uncertainty (lack of knowledge of which data is needed or to give priority: the radical uncertainty)<sup>2</sup>.

We have to give up an understanding of having a unified scientific basis as an unequivocal reference of knowledge creation and transfer in industrial settings. Instead we need to perceive communication on environmental properties of chemicals as conditioned by a world structured by practice communities and network each generating specific knowledge and cognitive structures - as presented above. The point is, that different 'fields of practices' constitute the context of the communication acts in which specific environmental knowledge on chemicals is exchanged and mutual common horizons of interpretation and sensemaking are shaped.

This forwards an understanding of environmental communication, where knowledge, perception and meaning on environment emerge through in these processes. Specific configurations of actors, problems, solutions and relations (within organisations, and in-between organisations in chains and network) evolve (March, 1999) in these processes and form *knowledge systems* or 'decision arenas' where specific forms of knowledge and communication processes are institutionalised. These emergent institutionalised forms of knowledge and communication processes enables the actors to develop shared mental constructions of problems, solutions and relations, which provide the means to address and deal with specific environmental problems.

Knowledge systems, as they emerges as institutionalised communicative practice between different fields of practice, in this way may be seen as specific settings enabling creation and transfer of knowledge across such fields of practice.

The dilemma is that institutionalised environmental knowledge systems are needed to act, but the risk is that rigidities are introduced, which may limit reflexivity. The problem of such knowledge systems (decision arenas) is that they both need an *operational closure* (programmes of routines, values and priorities, which can ease the communication when opposed with (eco)-

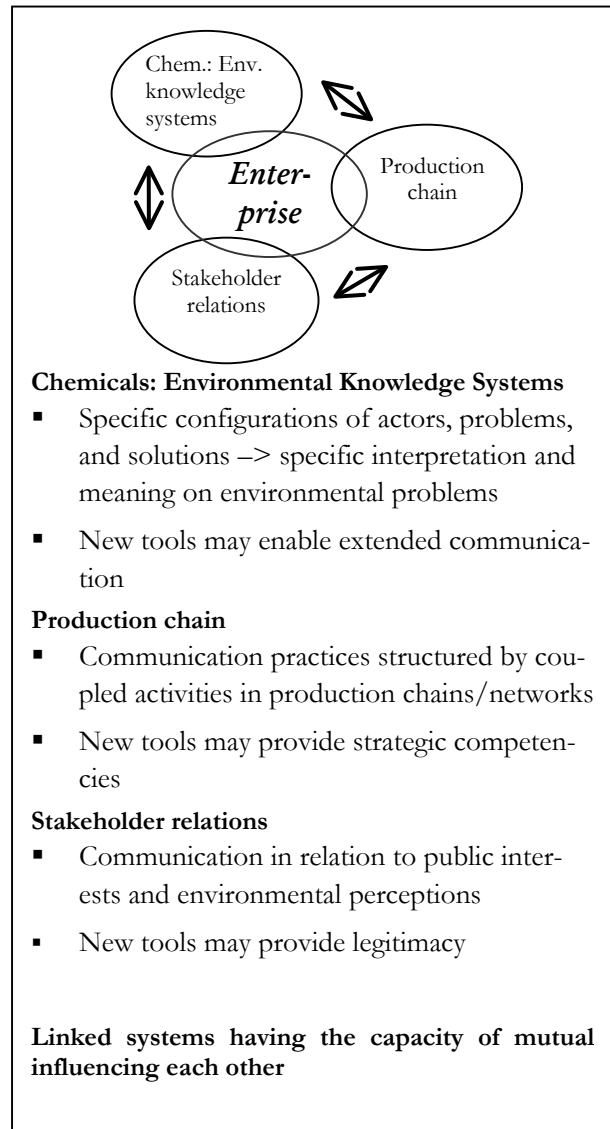
complexity) and *cognitive openness* (the ability to reflect on own selection criteria in the programmes - enabling sensibility e.g. to new agendas), which can make them responsive and innovative.

Building on this understanding we examine how enterprises exchange of environmental knowledge on chemicals externally and internally is conditioned.

### Environmental communication of enterprises in context

Enterprises interact with and within a wide number of different practice communities or practice networks, where environment are communicated and interpreted. Still perceiving knowledge as situated enacted practice - and making emergent practice communities and networks the constitutive arenas – enterprises are interlocked in webs of ‘fields of practice’. Looking at enterprises, examples of such ‘field of practices’ can be routinised (operational) communication in supplier- or customer relations, or in the handling of wastewater problems in interaction with local authorities. Or it can be less routinised (strategic) communication with stakeholders, where environmental communication initiatives are taken to integrate loosely coupled and differentiated environmental perceptions among loosely coupled actors of ‘network of practice’, with the aim to shape specific frameworks of communication.

As a result enterprises communicate environment in a highly heterogeneous setting. One way to expose this is to look at three different spheres of environmental practices of the enterprises: *environmental knowledge network, product chain and network, and stakeholder relations in the public sphere*. Environmental perceptions, knowledge and meaning are embedded in different activities within the three spheres of practices – and different frames of environmental communication may be shaped.



*Figure 1: Coupling of enterprises on knowledge systems, production chain and stakeholder relations.*

These three spheres of practices provide three separate, yet interacting, systemic conditions of the enterprises. Each of them holds the ability to induce changes in the other two spheres. Changes in the environmental knowledge system may move perception, values and priorities in production network/chains and in public agenda/stakeholder relations - and vice versa.

In relation to environmental communication on chemicals, two points should be taken into account. First, in its environmental communication enterprises find themselves coupled in different

spheres of practice, which results in that very different demands on communication on chemicals may evolve. Second, any 'new tool', which should provide the means to communicate environmental properties of chemicals, influences and is influenced by practices and rationalities of the three spheres.

### **Chemicals: Environmental knowledge creation and transfer – three cases**

The notions of emerging knowledge systems and enterprises embedded in different spheres of environmental practices highlight the complexity of environmental communication of enterprises. In the remaining part of this section, we give three 'cases' on, how the problems of environmental knowledge creation and transfer take specific form when working with the implementation of an information system on environmental properties of chemicals.

#### **A. Acting in worlds of knowledge systems**

The problem of differences in knowledge creation, and hence the problem of transfer of knowledge, becomes specific if we look of specific practice network, which have emerged in the field of environmental impact of chemical. In the case in focus, an environmental department had to decide how they would report their environmental performance on chemicals. A number of different options were identified.

- a. They could subscribe to a specific Danish classification system placing chemicals in three groups (A, B, or C) depending on toxicity and impact on biological processes in waste treatment systems. This knowledge is strongly related to specific demands of the established waste treatment infrastructure and has been institutionalised in re-occurring negotiations on permits with local authorities.
- b. They could subscribe to standards elaborated for environmental labels, taking this set of 'best and wanted practices' negotiated

in Scandinavian (The Swan) and European (The Flower) arenas. While strong on addressing consumer, they prove weak on process-performance.

- c. They could subscribe to classification systems based on the use of Risk and Safety Phrases elaborated within the framework of The European Unions regulation (directives on substances and preparations).
- d. They could subscribe to national (Danish) lists of 'unwanted substances' elaborated by the Danish Agency on Environmental Protection. Have proved a strong message in the production chain.
- e. Or they could make use of an internal list of substances (unwanted – to be reduced or phased out in production) used in their internal environmental management and in supplier relations.

Each of these systems, elaborated to enable distinctions on environmental properties of chemicals and communicate environmental performance, can be seen as situated in specific practices. And using the situated knowledge outside these practices, with the aim to document environmental performance to external stakeholder, prove to be difficult. A distinction on classes A, B, and C, based on effects on a specific waste treatment set-up, does not make much 'sense' when communicated to customers. In general, each option will have legitimacy to some problems and actors, while they could be criticised from the positions of other problems and actors.

The case, which evolved in a specific situation where a report strategy of the enterprise had to be developed, reflects a more basic condition of environmental departments. If we look at the institutional framing of the work with chemicals and environment, environmental managers and departments find themselves involved in a number of different networks of practices, each offering a specific constellation of actors, prob-

lems and solution. Looking at chemicals in a Danish context it could involve:

- A recipient-oriented practice emerging in relation to the permit-and-control regulation and cleaner technology programs (see Hansen, 2002).
- A life cycle assessment (LCA) practice emerging in relation cleaner technology programs and product oriented programs.
- A market oriented practice emerging in relation to label-institutions or public procurement guidelines
- A environmental health practice emerging in relation to safety work and chemical management

In each of these settings, environmental knowledge on chemicals evolves as specific situated practices. In a Danish context the specific actor-network, emerging around methodological work on LCA-tools (UMIP) may be an example.

Looking at environmental management and units in this perspective, they are or can be inscribed in a number of different practice networks (knowledge systems), each offering specific representations of the environmental problems of chemicals within frames of situated enacted practice. It illustrates, in addition, how environmental agents potentially are enrolled in many separate network of practices, making it a problem how they mediate and manoeuvre between those emerging different 'knowledge systems'.

### **B. The enterprise as a distributed knowledge system.**

The expansion of the scope of environmental management, e.g. adoption of product and chain oriented strategies, has implied that handling of environmental issues now pervade the entire organisation in enterprises. Environmental management for this reason transforms to a polycentric activity leaving environmental management units with highly extended tasks of knowledge

management and communication. New main tasks involves:

- To transfer and integrate environmental knowledge and objectives to other functional units and
- To identify and absorb environmental knowledge created in other functional units

The handling of these tasks has to be considered of pivotal importance if enterprises are going to create (dynamic) organisational capabilities to conduct e.g. chain management (de Bakker, 2002).

Implementation of environmental management systems has traditionally been a centred process, placing a high focus on how to roll out procedures and integrate environmental objectives and schemes in other units. Implementation of specific chemical management system has often taken the same road; centralised programs (classifying and defining goals of reduction and phase out) has been introduced with the objective to have them integrated in the routines and decision making throughout the organisation. This has proved to be difficult of several reasons:

- Implementation of environmental optimised standard processes in local production units confronts with local practices and experiences.
- Internal implementation of environmental programs and routines faces a major obstacle in the 'cognitive distance' of central environmental management and practices in local units. An example could be the attempt to integrate environmental considerations in the handling and use of construction chemicals. The 'cognitive distance' in relation to chemicals may be seen as a result of specific practice communities among the different professions of workmen, where knowledge creation in relation to materials centre on functional aspects (e.g. result/quality, ease of use, speed of process) and to some extent health issues. In the implementation, environmental management will have both to cope with the overriding rationality of cost

and time steering of the project, and a host of incompatible practice communities constituted by different (workmen) groups separated organisational, and in time and space at the project.

In general we face the problem of transfer of knowledge between different practice communities.

The other part of the problem, how to manage the enterprise as a distributed (environmental) knowledge system (Tsoukas, 1996), may prove to be even more important, if the organisational capability to meet and explore environmental challenges shall be developed.

Perceiving environmental work in firms as a de-centred system, made up of polycentric situated enacted practices of communities and network, makes it necessary to reconsider environmental management work:

- Environmental management programs have to be implemented in a structure constituted by different practices of production, sales, design, etc,
- Environmental management units need to have access to the specific environmental knowledge created in the practices of design, operation of production processes and sites, and sales and consulting. Environmental management has to manage environmental knowledge in the organisation, knowledge which is situated in emergent environmental practice communities
- Agents in the organisation and organisational units need to have the capacity to act in situations on environmental issues – and environmental management has to further such a development.

The former point may become even more important if we turn to the handling of stakeholder relations.

A major challenge to future environmental management is, how the organisation can develop capabilities to mediate and transform changing external expectations into strategic responses (de

Bakker, 2002). If we look at the processes of knowledge creation and external communication, a strategic approach aiming at the development of stakeholder relation and use of environmental competencies will place specific demands to these processes. Examining future corporate environmental reporting, Wheeler and Elkington (2001) have emphasises the need of

- Targeted and differentiated information to stakeholder
- Direct and interactive environmental communication with the individual units
- Readiness to engage in partnerships and to share information, innovation and learning processes.
- Identification and knowledge of environmental expectations of customers and stakeholders.

This may reinforce the tendencies of divergent internal distributed knowledge, as it may imply that the individual units and employees become part of emerging external network – and in this process they may develop specific practices and knowledge relatively independent of the firms environmental management.

This understanding of knowledge creation, bound to local sensemaking, decision processes and experience, challenges management options based on centralised management capacity (de Bakker, 2002).

### **C. Information systems and environmental knowledge creation and transfer**

The final case focuses on environmental communication on chemicals and the implementation of information systems. The question is, how such information systems can be perceived, when we take into account a) a concept of knowledge as situated enacted practice and b) the specific settings of environmental knowledge creation and transfer (see point a-b above).

In the implementation of scientific based information systems (as in the case of the “KEMI-

centre” project) on environmental properties of chemical we would have to consider:

- We will experience a plenitude of knowledge systems (configuration of actors, problems, solutions and relations) and practice communities surrounding environmental communication processes – environmental communication within these separate knowledge systems and communities of practices would be possible based on shared cognitive structures (specific selections of knowledge, perceptions and meaning)
- Each configuration implies specific needs of knowledge and knowledge tools.
- Communication between these communities would involve some kind of ‘translation’ to overcome the lack of a common cognitive structure. Knowledge will always be produced within specific relations (here conceptualised as configurations/communities) – and can, for this reason, not readily be transferred and used by others (actors outside the configuration/community).
- Each configuration/community would be temporary (always be subject to reinterpretation and strategic behaviour of the members – including the challenge of new agendas), which imply the need of knowledge tools, which allow a cognitive openness.

This perception of information systems and communication clashes with traditional ways of thinking information and expert systems.

## Notes

<sup>1</sup> KEMI-centre project (2000-04): Co-operation of enterprises, research centres and universities: Development of PC-based tools for documentation and communication on environmental properties of chemical. Funded by the Danish Ministry of Industry. Participants: DHI Water and Environment, DTC Danish Toxicology Centre, Skanska (dk), Akzo Nobel (dk), Brøste, Ecolab (dk), Berendsen, Hartmann, Department of Environment, Technology and Social Studies (RUC, Roskilde University), and Department of Manufacturing Engineering and Management (DTU, Denmark's Technical University).

<sup>2</sup> This does not imply a constructivistic view, but a critical realistic view of specific empirical representations of “the real” (ontological realism). Scientific data as subject to conceptual uncertainty (epistemological relativism) e.g. representations of eco-toxicity by data preliminary on marine impacts and a limited number of effects.

- Codifying strategies aiming at making simple representations or classifications of environmental properties of chemicals or substances risk not to meet the target, specific practice communities will need to have access to specific applications (based on the scientific core). And they even need a tool with a flexibility to re-conceptualise the application interface, to meet different and changing demands in their environment.

To meet these needs some kind of access to basic data on product is needed. This, on many occasions, conflicts with interests of chemical industry and suppliers; to protect their proprietary rights (know how/receipts), they want to restrict their exchange of information on environmental properties with customers and stakeholders. This has made the exchange of information within some kind of classification or ranking system (e.g. based on the European Unions risk-phrases) an option.

## Concluding Remarks

When environmental communication is perceived as knowledge creation and transfer within and between practice communities, we may understand the reason of unsuccessful communication and for this reason lack of environmental attention and acting within organisations and in networks/chains of organisations.

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