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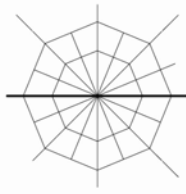

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Abstract

Innovation is a distributed process involving several actors and communities. The process dependent of the way knowledge is created and transferred inside and across the different communities. Building on knowledge management discussions, the paper suggests that environmental knowledge is created and shared through a transformation of knowledge inside and across communities and networks of practice. Knowledge is not taken as a given, but is conceived as situated enacted practice, which means that environmental knowledge has a different meaning and function in the different fields of practice. This also explains why it is so difficult to manage and integrate environmental knowledge inside and across communities and networks in companies, production chains and external relations.

Taking this theoretical approach, the paper shows how knowledge transfer across situated fields of practice in environmental knowledge networks, production chains and stakeholder relations in the public sphere. Environmental perceptions, knowledge and meaning are embedded in different activities within the three spheres of practice – and different frames of environment.

Creation and sharing of environmental knowledge across communities and networks

By Bent Søndergård, Roskilde University, Ole Erik Hansen, Roskilde University, Jesper Holm, Roskilde University and Søren Kerndrup, Aalborg University

Introduction

Innovation and entrepreneurship is becoming an increasingly important part of strategies for improving environmental effects of production and consumption. In order to understand this process there has been an increasing practical and theoretical interest in how environmental knowledge are created and shared inside and between enterprises, production chains and stakeholders.

In order to conceptualise these trends much research has emphasised the general processes organisations use to codify and transfer information. This work has emphasised structures and processes such as routines and procedures to codify and transfer information. (March & Simon 1958, Levitt & March 1988). Another trend had focused on knowledge transfer and how the problem tacit knowledge makes codification and procedures difficult to develop. This work has also emphasised stickiness of knowledge and the problems of articulating knowledge how and cultural constrains of transfer knowledge. (Bechky, 2003)

Although this work had made a significantly contribution to our understanding of why and how knowledge management and integration is so difficult, it also has some limitations, because it understand organisational meaning as universal and the context as relatively homogeneous. (Bechky, 2003)

In contrast to these positions this paper understand knowledge as situated, enacted practice, where knowledge creation and transfer is a complex process involving multiple actors and communities.

The problem of transfer of environmental knowledge is related to the concept of knowledge as situated, enacted practice in the following way.

The first is that we have no centre or privileged actors in the environmental knowledge creation. Extended environmental agendas, raising demands regarding sustainability, and addressing products in a life cycle perspective have all expanded the scope of environmental planning and management. Environmental changes of products in most cases have to be addressed as systemic, embedded in chains, networks and institutional settings.

Changes rely on and involve the change of product and technology systems, which involve changes in patterns of behaviour in civil society (e.g. patterns of private consumption).

The task of handling environmental issues pervades every level and functional unit of enterprises and product systems.

Speaking generally, environmental knowledge creation and transfer are polycentric activities, taking place in settings of knowledge and capabilities dispersed among many actors in communities and networks. The environmental knowledge and knowledge creation are distributed. And in environmental planning and management processes, environmental information and knowledge have to be transmitted, processed and acted upon within a broad array of organisations and actor constellations.

Second, environmental transfer is not only a question of passing information, but also a constitutive process; specific knowledge systems, actor coalitions and cognitive structures are co-produced through practice. Environmental information and knowledge are subject to selection and strategic interpretation, and specific paths and innovation systems co-evolve as the result of the communication processes. This implies that communities and networks (in their efforts to build environmental positions in markets or to develop new capabilities of environmental communication) simultaneously stage path-shaping environmental perceptions and cognitive structures.

Taking the distributed nature of environmental knowledge and transfer as a point of departure, this paper aims to understand the problem of the 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 (see below).

Environmental knowledge transfer across communities and networks in production chains and other external relations

Environmental knowledge transfer has been subject to growing attention within business management studies and constancy. The dominant approaches of these studies have been 'traditional' in terms of the scope of knowledge: taken knowledge as given, where knowledge is translated into tools on how enterprises most efficiently could promote their environmental knowledge (e.g. Valeur and Tinge, 2001). Another line of development has been environmental reporting and benchmarking (e.g. Wheeler and Elkington, 2001), etc. Strategic approaches have been present, but somehow basic problems of how common cognitive structures within 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 the absence of shared goals and priorities in the product chain formed major barriers to the exchange of environmental information. They emphasised the need to shape shared environmental reference systems in product chains, and the development of roles, capabilities and competencies of chain actors. In a microanalysis, Clarke and Roome (1999) demonstrated how the environmental relations of enterprises served as a learning-action network, in which enterprises developed specific environmental perceptions through complex

processes of negotiating, learning, action and change together with their stakeholders. Work on environmental innovations (Hansen et al., 2002, Søndergård et al., 2004) has pointed to how specific institutional arrangements and distributed innovative green capabilities evolve in sectors and industries and shape the way environmental problems and horizons of solutions are communicated. This finding is 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 communities and networks in organisations, 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 only how enterprises most efficiently organise their environmental communication, but also how the objects of environmental change are constructed. This involves an understanding of the basic question of how environmental knowledge is shaped and how the meaning of environment is produced, interpreted and organised in the (environmental) communication processes of organisation units, enterprises, product chains, and production systems.

Knowledge creation and transformation within and between communities 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 communities and networks of practice. By understanding knowledge as situated enacted practice, 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 is even more so when it is discussed in an environmental setting. A short looks at the knowledge management tradition display some of the complex ontological and epistemological differences:

The discussion between the information and knowledge perspectives, which has been seen in the differences between Simon/March, and Nonaka as 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 (stored in minds) or relational (residing in interactions), which is explicated in Stacey (2001).

Theoretical and empirical analyses (Hansen et al., 2002, Kerndrup et al., 2002a,b) have proved it 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 specific contexts. With this focus on the context of practice, 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 clarify the implications of this concept of knowledge, it is useful to look at the key elements of the definition:

By understanding knowledge as practice, we want to emphasise that knowledge is connected to practice in terms of 'knowing how', e.g. a capacity to act in specific contexts. When we ask about the environmental knowledge of people or industrial actors, we do not ask if they can cite the environmental encyclopædia, but if they are able to use knowledge about the environment to green their activities. Knowledge is the capability to draw distinctions within a domain of action; drawing distinctions in the process of carrying out work in particular context (Tsoukas and Vladimirou, 2001). In this perspective knowledge becomes a process of knowing; "an ongoing social accomplishment, constituted and reconstituted in everyday practice" (Orlikowski, 2002) Knowledge and practice are reciprocally constitutive and are inseparable. Furthermore, in understanding knowledge as practice we highlight that the tacit and explicit dimensions of knowledge are integrated and cannot be understood separately.

By understanding knowledge as situated, we want to emphasise that knowledge is embedded and embodied in specific (local) material and social settings. This social and material embeddedness of knowledge emphasises that knowledge is not going to be seen as either individual or 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 understanding knowledge as enacted, we want to focus on how knowledge is enacted as a sensemaking process, where sensemaking of actors are enacted through practice (Weick, 1995, 2001). A practice, where knowing is often retrospective and is enacted by creating stories in order to make sense in (complex) fields of practice. Stories, 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 our understanding of knowledge generation and transfer within and between organisations (e.g. firms in production chains and networks). It establishes a perspective that opens up for new ways of understanding ways of creating and distributing environmental knowledge.

A mayor distinction is connected to the understanding of the fields of situated practice as 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 of knowledge in

a practice perspective, given the situation 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 fields of practice.

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

Knowledge as distributed fields of practice: communities and networks 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 throughout society among different activities, actors, actants, and relations. A discussion, which has been raised by the Austrian school of economics in the writings of Hayek (1938, 1945), Loasby (1999), the philosophical writings of Hayek (1978), Ryle (1949), and in writings about management by Tsoukas (1996). The complexity and ambiguity of knowledge is related to the continuous enactment by the communicative practices within and across the different fields of situated practice.

By emphasising situated practice as the locus of knowledge development, knowledge is no longer seen as being 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, and 2002).

Common for these contributions, is a focus on knowledge as situated enacted practice with special emphasis on how 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 shared practice of day-to-day activities, where people make sense of what they do, how they do, and why they do it. Tight couplings of the day-to-day practices 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 continuous process of story telling. The paradigmatic case of sensemaking processes in situated practice is Julian Orr's study: 'Talking about Machines' (1996). In an environmental context, Fischer and Rosdahl (2001) have given examples of sensemaking processes among employees in a printing firm.

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

Knowledge is conceived as institutionalised practice (Kerndrup et al. 2002b). This also implies that sensemaking processes are seen, as enactment processes 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 se the enactment process as different from the way knowledge sociology try to reflect on path dependency as a process of establishing and closure.

Networks of practice

Networks of practice are loose couplings of people working with the same type of practice (or problem) in different settings, while their day-to-day practices are not connected. It can be links between people in 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 common 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 common knowledge of joint situated practice and sensemaking within networks of practice is enacted by common practice in different settings.

Knowledge 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 structured setting in which knowledge creation and transfer take place. A setting with local fields of 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 differences in sensemaking. The differences make 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 with in and between different fields of practice. In the next section we will examine such processes of translation and transfer of knowledge across situated fields of practice in relation to organisations, production chains and networks.

Creation and transfer of knowledge in organisations, 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 relatively homogeneous knowledge creating entities, and knowledge transfer/communicative processes as simple unequivocal processes. And develop a framework where organisations within production chains and networks and stakeholder relations 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 knowledge creation (Nonaka1994). Work, which have enhanced our understanding of knowledge creation and transfer in organisations in a simple transfer model where knowledge and context are relative homogeneous. (Bechky, 2003)

In particular, knowledge theory (Wenger 1998, Wenger and Snyder 1998, Brown and Duguid, 1998, 2000, 2001) has discussed knowledge creation and transfer in organisations in relation to fields of practice: 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 makes sense for the individuals. This means that communities of practice are autonomous emerging entities within and across organisational settings. Therefore, communities of practice cannot be designed or directed from above as task groups, departments, etc, but are 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 and networks of practice (Brown and Duguid, 1999, 2001) is a way to understand why and how different kinds of knowledge are created within organisations, and thereby understand the difficulties creation and transfer of knowledge within the firm.

Cognitive distance and absorptive capacity of communities become central notions to explicate barriers of knowledge transfer between communities of practice and networks of practice both within and between organisations – and to some extent to indicate ways of overcoming these difficulties.

Different kinds of practice mean that knowledge has to be translated from one field of situated practice to another field. In this translation process, the cognitive distance between the different fields of practice will be a decisive factor in understanding the difficulties of transferring knowl-

edge (Nooteboom, 2000). Cognitive distances between communities of research, communities of production, or communities of sale can be substantial and explain many of the failures of firms in sharing and making use of (environmental) knowledge. Distance relates to the cognitive domain (what is given attention) and cognitive range of categorisations, in short differences are related to differences in the cognitive repertoire:

When information does not make sense within the cognitive repertoire, 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. Environmental innovations developed in one community of practice (for example options of new products, materials, technologies, or behaviour) will not be used because they do 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-effects 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 productivity and planning, while the communities of sales and marketing dwell on how environmental problems are or can be part of customer relations.

Another barrier is absorptive capacity (Cohen and Levinthal, 1990), the ability to recognise, assimilate and apply external information, which can be ascribed to different fields of practice. The absorptive capacity has to be considered as dependent on prior achieved knowledge, and is, as such, history and path dependent. Studies show that the ability to use research based environmental innovations developed at universities is dependent of communities' experience and skills of research based innovation.

Cognitive distance and differences in absorptive capacity can be substantial due to disparity of 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 shared cognition based on the enacting, selection and retention of knowledge Weick (1979). Communicative acts across fields of practice are more complicated. Establishing communicative practices rely on the ability to translate complex and ambiguous information and knowledge in a way that makes sense between the different fields of practice.

This way of understanding environmental communication in organisations in a community of practice perspective challenges more rationalist approaches to environmental management. Differences in knowledge as situated enacted practice constitute an essential barrier to the process of dissemination/integration of environmental knowledge from environmental management unit out into the organisation, as well as to the process of bringing together and utilising knowledge from disparate units (see below, part II: Environmental communication in enterprises).

Production chains

The configuration of production chains is mainly seen as activity chains related to flows of materi-

als. 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 actors in the chain can practice in the activity fields and can connect to other activity fields along the chain (Richardson, 1972, Loasby, 1999). The understanding of capabilities as specific configured fields of practice, together with the concept of absorptive capacity and cognitive distance, provides a conceptualisation of the division of knowledge and of the way knowledge is developed, and can be transferred within and between chain actors (Kerndrup et al., 2002b). Communicative acts within production chains and networks take place in and co-shape specific settings of distributed capabilities.

Environmental problems are related to activities across the production chain, but the knowledge, which is involved in overcoming the problems, is related to the capability in the separate fields practice. It is the similarities and complementarities between these capabilities in different fields of practice that condition how and to what extent shared environmental knowledge can be developed and exchanged. 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 practice field's position along the production chain. The cognitive distance and differences in the absorptive capacity are often lesser between communities of practice in the same stage of production – a knowledge that intuitively is used in "ERFA Groups. 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 is very far away from the knowledge practice in small Danish textile firms. (Kerndrup et al. 2002b).

Stakeholders and other external relations

The configurations of stakeholders outside the production chain 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 the shaping of communicative processes very complex and ambiguous, which is why we only try to indicate these processes by focusing on a few key configurations – the interactions in:

Research and development practice.

Regulatory practice.

Non governmental stakeholders.

Research and development practices are related to 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. Knowledge developed in the research system reflects the scientific practice that is both similar and dissimilar to the R&D practice in production and has to be translated.

The cognitive distance between these systems means that firms often need to have research practice in order to benefit from 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 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 concerning the transfer of knowledge across different environmental knowledge systems and between chain actors, which may subscribe to a number of (often-disagreeing) knowledge systems. The existence of such different knowledge systems in relation to the environmental communication of enterprises represents a specific problem (Kerndrup et al., 2002a).

The environmental regulatory practice is founded on a practice very different from the business practice. The interaction of enterprises and environmental authorities, seen as communicative acts, has to be regarded also as a knowledge shaping and learning process (Clayton et al., 1999, v. Dijken et al., 1999, Søndergård et al., 2004, Hansen et al., 2001) a perspective that is not reflected in the traditional dicthonomy between command and control systems and markets based regulations.

In the change towards proactive regulatory strategies, the scope of communicative regulatory acts expands and takes new forms. Within schemes of capacity building and product orientation, the flow of information and knowledge has been much more complex and ambiguous. Environmental units now find themselves involved, simultaneously, in a number of interactions within different fields of meaning – both internally in organisations and externally.

Stakeholders with an ethical, social and/or environmental knowledge and interest is a very broad group of actors with a variety of practices making the interaction and sensemaking processes very complex. The importance of these communities and networks of practices is increasing and they seem to have an influence both directly and indirectly on creation and transfer knowledge. Some communities and networks have institutionalised their practice in ways, which make it more efficient to create and transfer knowledge across boundaries by reducing the cognitive distance to the other stakeholders and/or developing the absorptive capacity. Green Peace is an example of this kind of institutionalising by creating a top down organisation and developing research expertise. Other stakeholders become less institutionalised, which mean the cognitive distance to the other interest groups is greater and the absorptive capacity is lower. In these situations it will often be more difficult to create and transfer knowledge through a communicative practice because information and knowledge will make sense for one group is not making sense for other groups.

Bridging environmental practice

The ability to handle and communicate complex and ambiguous information and knowledge is great inside communities of practice due to a shared practice based on enacting, selection and retention of knowledge. Communication across fields of practice are more complex and the rely of the ability to develop a common frame to translate complex and ambiguous information and

knowledge in a way that make sense between different fields of practice.

Organisational studies looking at transfer and sharing of knowledge have given much attention to the problem of crossing boundaries of practice. This has brought into focus such issues as the role of gatekeepers, translators and knowledge brokers (Brown and Duguid, 1998) and boundary objects (objects (e.g. documents, protocols, standards…) that are or can be shared across different fields of practice. It is not al forms of objects or persons, which can be boundary objects or boundary spanners. (Carlile, 2002, Bechky 2003) In a practice perspective, knowledge is both sticky and leaky as it sticks to and flows with practice (Brown and Duguid, 2001) –making practice across boundaries and networks a critical issue.

Overcoming the differences is an obstacle to having a flow of knowledge, but also a source of new knowledge creation. Flows of knowledge are enacted through translation by use of institutionalised vehicles as discursive frameworks, stories codified standards etc. To ease and make use and sense of knowledge. Hearby new meanings and added value of knowledge are created and re-created.

Sverrison (2001), in his studies of environmental translations networks and knowledge brokers, has emphasis this shaping of specific knowledge in the transfer processes. He makes the observation that "this process of translation and communicating 'the environment' shapes a pragmatic environmental discourse continuously, everywhere and all the time, (p. 319) From his perspective, the framing of transfer is a contingent outcome of interactions and communicative practice, which develop between different fields of practice. This is in line with the learning-action framework of Clacke and Roome (1991), where shared environmental perceptions evolve in a process of negotiation, learning, action and change in and between the enterprise and stakeholders.

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 involve and be turned into institutions structuring the transfer of knowledge across fields of practice.

Environmental knowledge creation and transfer in knowledge systems, production chains and stakeholder relations

Enterprises interact with and within a wide number of different communities or networks of practice, where environments 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, exam-

ples 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 they 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 'networks of practice', to guide and shape specific frameworks of communication.

As a result, enterprises communicate environment in a very heterogeneous setting. For analytic reasons, we may differentiate between three spheres of environmental practices of the enterprises: (chemical) environmental knowledge networks, production chains and networks, 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. These three spheres of practices provide three separate, yet interacting, and systemic conditions of the enterprises. Each of them has the ability to induce changes in the other two spheres. Changes in the environmental knowledge system may have an impact on perception, values and priorities in production network/chains and in public agenda/stakeholder relations - and vice versa.

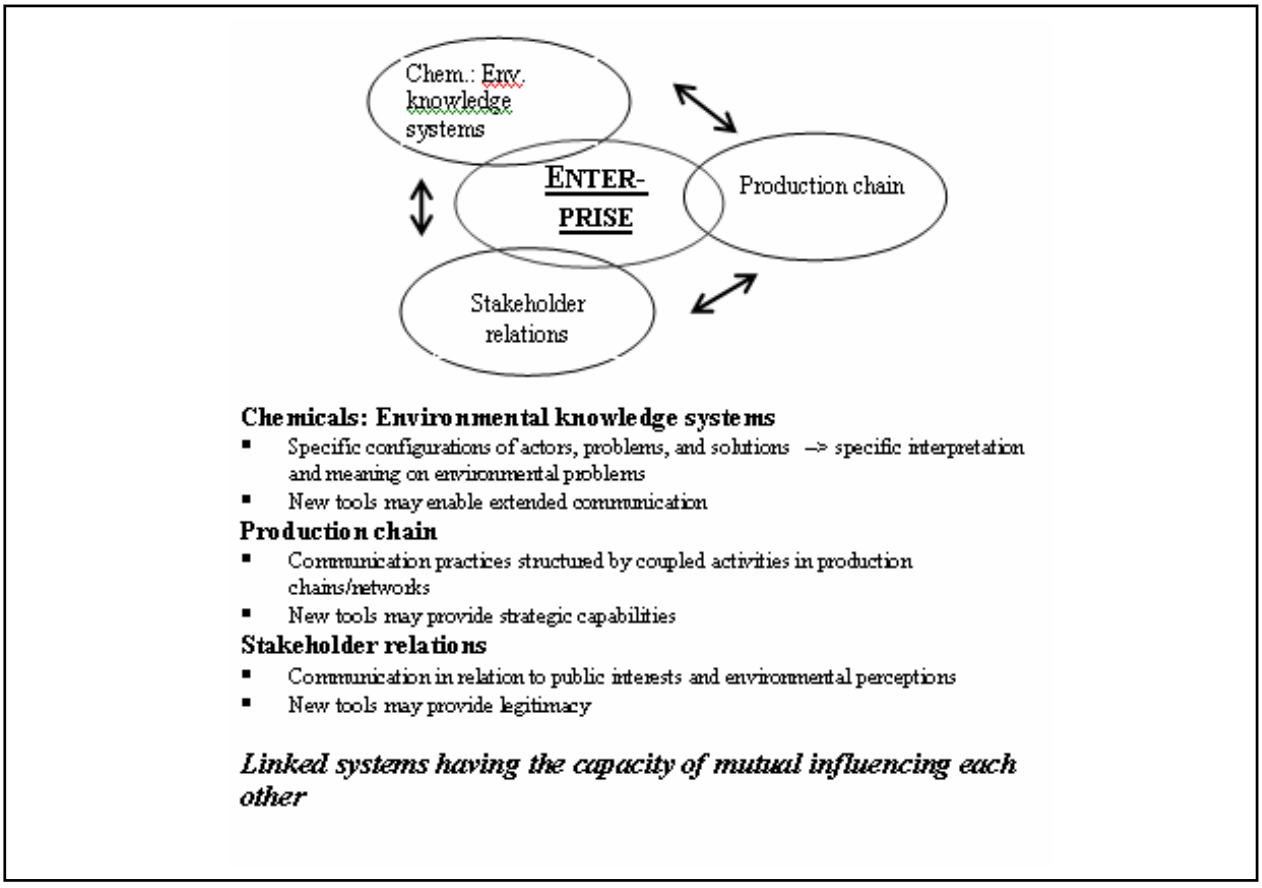

Figure 1: Coupling of enterprises on knowledge systems, production chain and stakeholders. Different roles of tools/information systems. Søren Kerndrup et al.

In relation to environmental communication concerning chemicals, two points should be taken into account. First, in their environmental communication, enterprises find themselves coupled in different spheres of practice, which results in that very different demands on communication concerning chemicals may evolve. Second, any 'new tool', which should provide the means to assess, document and communicate environmental properties of chemicals, influences and is influenced by practices and rationality of the three spheres (as indicated in figure 1).

The notions of emerging knowledge systems and enterprises embedded in different spheres of environmental practices highlight the complexity of the environmental communication of enterprises. The remaining part of this section presents 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.

Acting in worlds of different knowledge systems

The problem of differences in knowledge creation, and hence the problem of transfer of knowledge, becomes explicit if we look of the networks of practice which have emerged in the field of the handling of environmental impacts of chemicals. In the case investigated here, an environmental department had to decide how they would report their environmental performance relating to chemicals. A number of different options were identified:

They could subscribe to a specific Danish classification system placing chemicals into 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.

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 the consumer, they prove weak on addressing process-performance.

They could subscribe to classification systems based on the use of Risk and Safety Phrases elaborated within the framework of EU's regulation (directives on substances and preparations).

They could subscribe to national (Danish) lists of 'unwanted substances' elaborated by the Danish Agency on Environmental Protection. They have no mandatory status, but have proved to be a strong message in the production chain.

They could make use of an internal list of substances (unwanted, to be reduced, or phased out) used in their internal environmental management and in supplier relations.

Each of these systems, elaborated to enable distinctions on environmental properties of chemicals or products and to communicate environmental performance, can be seen as situated in specific practices. Moreover, using the situated knowledge outside these practices, with the aim of documenting environmental performance to external stakeholders proves to be difficult. A distinction in terms of 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 in relation 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, problems and solutions. Looking at chemicals in a Danish context, such framing could involve:

A recipient-oriented practice emerging in relation to the permit-and-control regulation and cleaner technology programs (see Hansen et al., 2003).

A life cycle assessment (LCA) practice emerging in relation to cleaner technology and product oriented programs.

A market oriented practice emerging in relation to label-institutions or public procurement guidelines.

An environmental health practice emerging in relation to safety work and chemical management.

In each of these settings, environmental knowledge concerning chemicals evolves as specific situated practices. In a Danish context, the specific actor-network emerging around methodological work on LCA-tools (UMIP) may be a specific 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 are potentially enrolled in many separate networks of practices, making it a problem how they mediate and manoeuvre between those emerging different ‘knowledge systems’.

The enterprise as a distributed knowledge system

The expansion of the scope of environmental management, e.g. adoption of product and chain oriented strategies, tends to transform environmental management to a polycentric activity, leaving environmental management units with extended tasks of knowledge management and communication. The main new tasks involve:

Transferring and integrating environmental knowledge and objectives to other functional units.

Identifying and integrating 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. green chain management (de Bakker, 2002).

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

The implementation of environmental optimised standard processes in local production units collides with local practices and experiences.

The 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 into the handling and use of construction chemicals. The ‘cognitive distance’ may be seen as a result of specific communities of practice at the construction sites among the different professions of workmen, where knowledge creation in relation to materials and chemicals centres on functional aspects (e.g. result/ quality, ease of use, speed of process) and to some extent health issues. In implementation, environmental management will have both to cope with the overriding rationality of cost and time management of the project, and a host of incompatible communities of practice constituted by different (workmen) groups separated organisationally, 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 is to be developed.

Perceiving environmental work in firms as a de-centred system, made up of polycentric situated enacted practices of communities and networks, 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 obtain 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 that is situated in emergent environmental communities of practice.

Agents in the organisation and organisational units need to have the capacity to act in various situations relating to environmental issues – and environmental management has to further the development of such capabilities.

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 approaching aiming at the development of stakeholder relation and use of environmental capabilities will place specific demands to these processes. Examining future corporate environmental reporting, Wheeler and Elkington (2001) have emphasised the need of:

Targeted and differentiated information to stakeholders.

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).

Information systems and environmental knowledge creation and transfer

How can scientifically based information systems be a tool of knowledge sharing and communication in relation to separate knowledge systems and communities of practices, where each configuration has specific cognition and would operate with specific needs in relation to knowledge and knowledge tools.

Knowledge sharing as target

A science-based information system could be seen as a boundary object – data/data structures that can be shared across communities of practices. The question is how "the system" may inform and shape trans-boundary practises.

Carlile (2002) points to three different ways in which 'a boundary object' may enable knowledge transfer across boundaries, as a shared syntax, a shared semantic or a pragmatic, shared practice. In all three respects, a science-based system would have to be adapted to cope with the task.

If implemented, “the system” will provide a stabilised common syntax for documenting the environmental properties of chemicals within the enterprise – and transfer of data and information will be facilitated. The problems of imposing a unified system on the different communities of practice are, however, equally evident. As a science based system, it may be biased towards (eco) toxicological representation, leaving the task to upgrade it in relation to other approaches, such as a life cycle perspective, b) the dedicated and specialised syntax’s evolving and serving practice in different part of the organisation may be suppressed. Even a common use of data and information requires a very adaptive implementation of the system if knowledge sharing should be achieved. These problems can, to some extent, be related to semantic barriers – the question of differences in cognitive repertoire. Knowledge sharing with production may a case in point. In a call for changes in process chemical, which may improve products in a LCA perspective, central staff units may experience that properties of chemicals are dealt with in relation to process and product quality outcome, and within specific environmental perceptions (e.g. good house holding within a formalised environmental management system). “The system” may mediate between these differences, but it will take an interactive approach; that is it will focus on how “the system” may support or enable a common practice, where shared cognitive repertoires are shaped.

At the root of this problem lies the question: how can ‘a science-based system’ be related to “knowing how” in specific practices. Taking the case of production a little bit further – a “system” without a ‘production entry’, enabling generation, storage and sharing of data on production and quality issues of chemicals, would risk failing to attach to established practices. If the system, as a knowledge-sharing tool, has to fulfil a role of enhancing local capability, it has to provide tools and applications, which relate to needs and problems faced in the local practice.

In a pragmatic approach (Sverrisson, 2001, Carlile, 2002), an information system is seen as a boundary object by the practices of translating and communicating (environmental) knowledge. This it may install between fields of practices. It places the focus on how specific framing emerges as the outcome of reoccurring interactions and communicative practices. In this perspective, the introduction of tools, such as an information system, is seen as means of shaping and changing trans-boundary practices.

External communication in product chains as target

Looking at environmental communication in chains, there will not be a privileged system in advance – on the contrary, enterprises in their external communication may expect a highly dispersed system of knowledge framing their external environmental communication. An example may elucidate this point.

A producer of packing material addresses three different markets – each showing quite different settings of environmental communication: a) mature market of standard package, focusing on price, delivery and quality, b) a market of producers of branded end-product paying a great deal of attention to environmental demands in a life cycle perspective and c) a market food producers (retail chains) where food safety has the highest priority. The question of compliance with customer demands has to be resolved within three very different institutional settings.

The implementation of a science-based information system establishes new environmental competence's, but it will only turn into a strategic capability when enacted by interaction with specific customers (or stakeholders) (Croom, 1997). It is in the specific knowledge creation processes in the interaction that such a system can be a strategic asset. It can be an asset by adaptive learning process, in which high quality and efficiency in the exchange of data and information are achieved within a stabilised perception of what should be communicated (operational environmental communication). Or, more important, it can be part of a generative learning process where new frames of exchange of knowledge are construed.

In both cases a science-based system does not provide a privileged tool. On the contrary, it has to be adapted to the interactions of the specific chain relation (e.g. develop applications for documentation of food safety) or to be developed as part of an interaction in which specific interpretations are shaped. An example of the latter can be co-operation with the customer, in which good LCA performance is attached to the product and turned into a market parameter. A process, which in turn, has made LCA-knowledge into a strategic asset.

Concluding remarks

It is a basic belief of the paper that environmental communication and knowledge management capabilities should be identified as essential elements in upgrading of environmental management schemes, both to comply with a changed environmental agenda and to exploit strategic opportunities. The presented conception of environmental knowledge processes here offers an alternative to more rationalistic approaches to environmental management and communication. Understanding processes of environmental knowledge creation and transfer as placed in settings of situated sensemaking in communities of practice implies that research on development of environmental management should pay attention to:

How situated environment knowledge is shaped in communities of practice.

How such a differentiated and distributed knowledge conditions environmental management.

How interaction shape frames of trans-boundary transfer of environmental communication.

How specific environmental knowledge systems emerge and condition knowledge creation and transfer.

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Conception	Environmental knowledge and transfer	Environmental management implications
Knowledge: Situated enacted practice.	▪ Environmental knowledge as social and material embedded in local context. ▪ Practice: Knowledge and acting cannot be separated.	▪ Scientific codified environmental knowledge insufficient platform. ▪ Contingent nature of environmental knowledge.
Knowledge creation: Local fields of practice.	▪ Environmental knowledge is distributed – resides in locale practices.	▪ New focus on local sense-making in organisational units – no privileged actors. ▪ Starting point: Settings of situated sensemaking in communities of practice.
Knowledge transfer: Translation.	▪ Environmental knowledge flows between fields of practice with different cognition.	▪ Environmental communication conceived as a translation.
Communicative practice: Institutionalised frames and knowledge systems.	▪ New institutional frames evolves from communicative practices (interaction).	▪ Address the process of interaction, to enable knowledge sharing across communities of practice.

Figure 2: Summary of conclusion

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