WORMHOLES TO ORGANIZATIONAL EXPERTISE: THE MANAGEMENT OF METAKNOWLEDGE

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ABSTRACT

Current theories on organizational learning, knowledge representation, and knowledge management conceive organizational knowledge as shared knowledge. Furthermore, the purpose of managing knowledge in organizations is to share the not-yet-shared. The scope of this paper is to analyze current problems in the representation and management of organizational knowledge. We will outline a concept that emphasizes the unshared rather than the shared aspects of organizational knowledge. Moreover, we propose a model of organizational knowledge representation, development, and management that includes distinctions between various kinds of knowledge. We also provide an example from an empirical study and an application to management accounting.

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On stardate 46392, Commander Benjamin Sisko and Officer Jadzia Dax discover the first known stable wormhole, the Bajoran wormhole, located close to space station Deep Space Nine. According to Krauss (1995), a wormhole is a shortcut in spacetime under the assumption that the four-dimensional space-time-continuum is curved. For the Bajoran wormhole this means that a point in spacetime, which is 70,000 light-years away, can be reached through an only 67-year shortcut.

Knowledge is commonly understood as a key concept for comprehending and managing organizations. Already in 1963, Cyert and March (1963/1992) proposed a model for organizational learning through adaptation, in which they assume that all organizational action is based on knowledge and information processing. March and Olsen's (1976) outline of organizational learning cycles and Argyris and Schön's (1978) Organizational Learning show that the rise of organizational learning and knowledge management dates farther back than the 80s of the past century. Contemporary concepts as the resource-based view of strategic management (Barney, 1991; Teece, 2000) emphasize competitive advantage through knowledge. Furthermore, concepts of organizational learning either focus on the process of change of the organizational knowledge base (e.g. Duncan & Weiss, 1979) or on the problem of designing organizations that enable learning (e.g. Senge, 1995). Despite contrasting views and distinct approaches, the necessity for organizational knowledge management in general and striving for a shared, common knowledge base in particular is common ground among most researchers.

However, in a society that is characterized through fast growing knowledge bases, higher specialization, and complex, dynamically changing systems, the attempt to share all required knowledge cannot but fail (cf. Simon, 1951). Thus, the necessity arises to find a shortcut, comparable to a wormhole, that allows a faster and more efficient access to knowledge distributed in diverse areas of expertise.

Before presenting our model of organizational knowledge representation, development, and management, we will analyze some major approaches and their characteristics in the light of the underlying cognitive psychological concepts learning, memory, and knowledge. These clarifications will enable us to build a model that embodies these basic concepts as well as a proposal for the organization of knowledge in complex social systems.

1. LEARNING, MEMORY, AND KNOWLEDGE

As Frensch (1998) states, "the better a meaning captures the boundaries of a concept, that is, the less fuzzy the boundaries are, the better the meaning facilitates communication" (p. 49). Through the evolution of various concepts in the organizational learning and knowledge management literature, their boundaries became somewhat fuzzy, and the concepts seem no longer to facilitate communication as well as they could. Therefore, to clarify a number of confusions regarding definitions and meanings of the concepts learning, memory, and knowledge, we will start out with defining these interrelated concepts by recurring to their domain of origin, cognitive psychology.

Cognitive psychology defines learning as "the process by which relatively permanent changes occur in behavioral potential as a result of experience" (Anderson, 1995, p. 4). The term "behavioral potential" indicates that actual changes in behavior are not imperative. As Bandura (1965) shows a distinction has to be drawn between learning and behavior inasmuch as something can be learned without resulting in observable behavior. This is the fundamental progress compared to behaviorist approaches. The term "relatively permanent" in the definition excludes temporary changes, e.g. due to fatigue. Finally, the term "experience" suggests that no developmental (e.g. achieving legal drinking age) or physical (e.g. a disease or an injury) changes should be considered as learning.

While learning is defined as a process of change, memory is conceived of as the product of change: "Memory is the relatively permanent record of the experience that underlies learning" (Anderson, 1995, p. 5). Memory in this view is the result of processes that lead to a changed potential, but not necessarily to different behavior. Memory serves as a storage device for these changes.

If learning is seen as a process of change and memory as a product of change, knowledge can be characterized as the content of change. Klix (1988) defines knowledge as propositions of properties ascribed to an object. Seel (1991) views knowledge as a cognitive phenomenon that is a result of either experience or inferences. He states that knowledge is constructed and that it aims at developing and maintaining invariants. Knowledge is a result of absorbing, processing and storing information in memory. Thus, contrary to widespread conviction, knowledge is not 'everywhere' in our society or in machines etc., but is inevitably connected to a cognitive system.

The theory of semiotics can be applied here (for an overview cf. Krampen, Oehler, Posner, & Uexküll, 1981). Things or objects do not have meaning in themselves. Meaning is ascribed or attributed to things through a cognitive system, for instance a human being (cf. Uexküll & Kriszat, 1934/1983 for other than human beings). Aesthetic qualities, e.g. beauty, are also ascribed to objects. Before the statue of the Venus of Milo, for instance, was rediscovered, it is not reasonable to describe the statue as beautiful. Only the perception through a cognitive system provides this attribute. For a statistical program, as e.g. SPSS, data are figures without meaning. Only a cognitive system provides the interpretations that are necessary to treat data on a matching scale level. Hence, knowledge externalized in databases cannot have meaning in itself as its correct interpretation is tied to a system of signs. Consequently, for our purposes we will label things without meaning as data, things reflected through a cognitive system as information, and things integrated in the context of a cognitive system as knowledge.

2. CONCEPTIONS OF ORGANIZATIONAL LEARNING AND KNOWLEDGE

There are two contrasting views in the literature concerning the concept of learning. The first view conceives organizational learning as a change in knowledge that results in observable changes in organizational behavior. E.g. Argyris and Schön (1996) define organizational learning as a change in the organization's theory-in-use which results in changed organizational behavior: "The attribution of organizational learning is contingent on the presence of an observable change in behavior" (Argyris & Schön, 1996, p. 33; cf. also Daft & Weick, 1984; Fiol & Lyles, 1985; Levitt & March, 1999; March & Olsen, 1976). However, these approaches are far from being behaviorist in their consideration of cognitive processes

like, e.g., the change of interpretations (Daft & Weick, 1984) or decision rules (March & Olsen, 1976).

In contrast to these approaches, Huber (1991), as an exponent of the second view, defines organizational learning as change in potentials of organizational behavior. He states, "learning need not result in observable changes of behavior" (Huber, 1991, p. 89). Similarly, Duncan & Weiss (1979) see organizational learning as a change in the knowledge about action-outcome relationships. This view is more in accordance with the view of cognitive psychology and thus we will refer to organizational learning only as change in knowledge and of behavioral potentials in organization. Organizational learning does not necessarily result in observable changes of organizational behavior.

If learning is seen as the result of experience, the question arises what the counterpart of experience at the organizational level is. Dodgson (1993), in his review of organizational learning literature, identifies adaptation to environmental changes and improving efficiency as motives for organizational learning. Levitt and March (1999) differentiate between learning from direct experience and learning from the experience of others. Weick and Westley (1996, p. 449) view "mindful moment[s] in action routines when order and disorder are juxtaposed" as occasions for learning. Common to all these instances is that learning results from the experience of individuals, and therefore individuals, not organizations, learn (cf. Argyris & Schön, 1996).

As stated in the previous section, memory is a storage device for knowledge and a result of learning. Most approaches to organizational learning assume not only people's memories but also further devices as storage facilities for organizational knowledge, i.e. as organizational memory. In the most comprehensive model of organizational memory, Walsh and Ungson (1991) list six retention facilities, or "storage bins": individuals, organizational culture, transformations (i.e. standardized procedures), role structures, ecology (i.e. the physical work environment), and external archives like former employees, competitors, the media etc. Furthermore, technical storage facilities like files or computer systems can also function as means for storage of knowledge (Argyris & Schön, 1996; Huber, 1991).

However, in a cognitive psychological view, only cognitive systems, i.e. people, can store knowledge (cf. e.g. Dodgson, 1993; Duncan & Weiss, 1979; Nonaka & Takeuchi, 1995). Other storage facilities like computer databases only contain data. To generate knowledge these data have to be interpreted by individuals and integrated into meaningful contexts. Routines, structures, organizational culture, and physical artifacts only reflect or represent knowledge because they are the results of knowledgeable individuals' actions. They are not storage facilities.

An example described by Anand, Manz, and Glick (1998) shows how two waves of changes in the management of a firm led to loss of knowledge regarding expertise available in the firm because the new management was uninformed about the expertise of an engineer. This loss is due to the fact that knowledge is only available in individual memory. If people leave a group or a firm, memory or knowledge loss is inevitable. Even if data about the qualifications of the engineer were available in a database, these data must be used and interpreted by cognitive systems. Thus, memory and knowledge are always tied to people.

Finally, the content of organizational memory, i.e. the object of organizational knowledge, has been described, e.g., as "theories of action" (Argyris & Schön, 1996), "routines" (Levitt

& March, 1999), "action-outcome relationships" and their conditions (Daft & Weick, 1984; Duncan & Weiss, 1979), and traditions, values, and norms (Hedberg, 1981). This may be summarized as knowledge about organizational processes and organizational culture. Common to all approaches to organizational learning and knowledge is the assertion that organizational knowledge is shared knowledge (Shrivastava, 1983). Even if the importance of unshared specialized knowledge for organizational success is explicitly emphasized it is contended that to count as organizational this knowledge has to be converted into shared knowledge, as, for instance, Duncan and Weiss (1979) state.

This focus on shared knowledge does not take into account some fundamental problems of human cognition. First, the sharing of knowledge in organizations is severely bounded by the limited cognitive capacities of people (Simon, 1951). Second, if knowledge as the result of learning is based on people's experiences their individual stocks of knowledge will be highly idiosyncratic. Transfer of knowledge between individuals will be problematic. Furthermore, the taken-for-granted assumption that only shared knowledge is efficient for organizations must be questioned.

3. TYPES OF KNOWLEDGE AND TRANSACTIVE KNOWLEDGE SYSTEMS

The evolution of social systems, whether societies, cities, or organizations, is characterized through one central feature: the division of labor and expertise. Societies, for instance, produce leaders, caretakers, or artists. Cities are a product of the division of labor between agriculture and crafts. Organizations are social systems that explicitly derive the rationale of their existence from the division of labor and expertise (Crozier & Friedberg, 1980). The more complex a task is, the more diverse the expertise needed will be to complete it successfully. In Steiner's (1972) terminology of group task types, additive tasks require division of labor, but the least division of expertise, as each individual's subtask is identical. Individual input adds up to (potential, quantitative) productivity. The most complex task type, discretionary tasks, requires division of labor as well as division of expertise.

In organizations discretionary tasks usually play a more important role than additive tasks. Tasks in organizations are often complex, dynamic, fuzzy, and muddled. The task circumplex model (McGrath, 1984) describes the diversity of tasks for groups and organizations along two orthogonal dimensions: conceptual vs. behavioral tasks and conflict vs. cooperation tasks. Organizations often comprise a mix of all task types, and hence, subtasks are created, and specific expertise is required to handle each subtask (cf. Arrow, McGrath, & Berdahl, 2000). Thus, division of expertise and diverse knowledge is a basic condition for organizational success and enables an organization to react adequately to task requirements and environmental changes. However, division of expertise and diverse knowledge imply that unshared knowledge rather than shared knowledge is important to and required in organizations. The question arises then how cooperation in a group or an organization is possible, and how far knowledge can be shared after all.

In every social system there is a more or less widely shared stock of knowledge, a common ground that is the prerequisite for basic mutual understanding and the ability to cooperate. Examples for this common knowledge are language, social rituals like shaking hands, or organizational culture. The higher specialized a social system gets, the fewer people will share a common knowledge base. For instance, the scientific classification of flies in biology is so highly specialized that there may internationally only five or six people share sufficient

knowledge to communicate about their work. Despite that, we are able to communicate with these fly experts as long as they are talking about their knowledge, and not about classifying the flies. We are even able to access their knowledge because we know that they know without knowing what exactly they know. In an organization, knowledge on taxation is highly specialized expertise that only a few experts share. It is possible to access their expertise, e.g., for accounting purposes or investment appraisals, if it is known that they are experts. It is not necessary, and often not even possible, for the accountants to have in-depth knowledge on taxation.

Knowledge about knowledge is called metaknowledge, while cognition about cognition is called metacognition (cf. Yzerbyt, Lories, & Dardenne, 1998). We will use the terms metaknowledge to describe knowledge that is reflecting itself, and metacognition for cognitive processes that are applied to themselves.

A model that deals with the division of knowledge and the creation of metaknowledge is Wegner's model of transactive memory (Wegner, 1987, 1995). Originally designed to describe the division of expertise in close relationships, the model has been applied to groups in general (Moreland, Argote, & Krishnan, 1996, 1998), to work groups in organizations (Brauner, 2001; Moreland, 1999), and it has been transposed to a general organizational level (Anand, Manz, & Glick, 1998).

The basic idea of a transactive memory is that person A knows about the knowledge of person B, hence she has metaknowledge on B's knowledge. Person A is then able to retrieve and use information needed from person B's knowledge base without wasting too much space in her own memory. Wegner (1995) describes a transactive memory through using a computer network analogy. Figure 1 illustrates a simplified version of Wegner's transactive memory computer model. Each person has a memory at his or her disposal. Furthermore, each person possesses a directory, i.e. metaknowledge, of his or her own knowledge. And finally, each person also generates a directory of the other person's knowledge, i.e. metaknowledge on B's knowledge. Thus, people acquire not only knowledge about the world or about areas of expertise, but they also develop metaknowledge both on their own and on their partner or coworker's knowledge. This metaknowledge is generated and developed through communication and (inter-) action and is therefore called transactive memory.

The main advantage of a transactive memory system is that it enables us to use people as memory aids (besides other memory aids, such as e.g. computer databases) through externalizing knowledge. What remains in the individual's memory is the metaknowledge, i.e. knowledge about the organization of knowledge and about strategies how to retrieve the knowledge. The knowledge itself is allocated in other peoples' memories. This structure saves memory space and enables a couple or a group to handle more complex and diverse problems. A major disadvantage of transactive memory, however, is that a loss of group members implies a loss of knowledge (Brauner, 2001; cf. the Anand et al. example cited above).

In a modified model of a transactive knowledge system (TRAKS), Brauner (in prep.) differentiates between two types of metaknowledge. First, declarative metaknowledge comprises knowledge about the content and the quality of knowledge. It contains furthermore knowledge about the distribution or location of knowledge, e.g., knowing about the contents of memories of a specific person or knowing about the usefulness of knowledge (Hasselhorn, 1992). Besides other people, locations can include own memory, books, databases, etc. When

processed and stored, this type of metaknowledge results in declarative metaknowledge again.

Second, procedural metaknowledge includes strategies for the acquisition of knowledge on the one hand and strategies for the evaluation of knowledge on the other hand. Strategies for the acquisition of knowledge comprise e.g. using mnemonic devices to memorize things or perspective-taking to understand a partner's point of view. Procedural knowledge on the acquisition of knowledge leads to declarative knowledge. Strategies for the evaluation of knowledge include, e.g., double-checking results of a calculation task or browsing through a text to decide whether it will be easy or difficult to read. Procedural knowledge on the evaluation of knowledge leads to declarative metaknowledge, because the quality of own or other's knowledge can be reflected upon as a result of the evaluation process. In a transactive knowledge system, accordingly, declarative and procedural metaknowledge is applied to access external knowledge stored in other people's memories.

4. ORGANIZATIONAL KNOWLEDGE REPRESENTATION

Contrary to popular belief in the literature on organizational learning we state that achieving a completely shared knowledge base is neither possible nor useful in organizations. We claim that a diverse knowledge base, i.e. unshared knowledge, is essential for mastering complex organizational tasks. However, without a common knowledge base cooperation and communication could hardly succeed. The transactive knowledge system with its differentiation between two types of metacognition allows for a conceptualization of the social organization of knowledge and metaknowledge (cf. Brauner, in prep.). Thus, besides a commonly shared, but more general knowledge base, expert knowledge is necessarily predominantly unshared. Nevertheless, people can catch an idea of other people's knowledge through acquiring metaknowledge on each other's (expert) knowledge base. Hence, organizational knowledge representation is conceived of as (mostly) unshared knowledge and (at least partly) shared metaknowledge.[1] As we claim that knowledge cannot be stored or created independently from individuals, our model grounds exclusively in individual knowledge.

Figure 2 depicts our concept of organizational knowledge representation. Individuals working in organizational subunits develop transactive knowledge systems (TRAKS), which they need and use to accomplish their tasks. TRAKS are developed through communication and (inter-) action, particularly through using procedural metaknowledge for the acquisition of knowledge (cf. Brauner, in prep.). Furthermore, group socialization processes play an important role in the development of TRAKS (cf. Moreland & Levine, 1982). Associations between different organizational subunits lead to a network of organizationally interconnected TRAKS. High interconnectedness means higher developed organizational TRAKS. The larger an organization is the more difficult will it be to achieve high interconnectedness. However, we view high interconnectedness as crucial for organizational success.

Brauner, Finke, and Scholz (2000) conducted a study in a research and development department of a large German company. Participants (30 males) filled in a questionnaire containing scales on work climate (Rosenstiel, 1992), subjective work analysis (Udris & Alioth 1980), and collective self-esteem (Luthanen & Crocker, 1992; Weidekamp & Rose, 1991). Furthermore, they kept a diary for five workdays, where they noted and classified all

work related contacts. Results show that some members of the department had good and efficient metaknowledge while others had inefficient metaknowledge. Efficient (or inefficient) metaknowledge were operationalized through the number of successful (resp. unsuccessful) contacts (e.g. did the person receive the desired information). It seems important to mention that quality of metaknowledge was not consistent with interaction networks. Among all participants, job satisfaction was relatively low. However, participants with inefficient metaknowledge scored even lower on several scales. Thus, results show that well developed metaknowledge and high interconnectedness can be essential for job satisfaction and hence for organizational achievement.

Connections between organizational units or even within units need not necessarily to be mutual (cf. also Anand et al., 1998). People can have one-sided metaknowledge about their coworkers (or other people in general). Famous and high status people are often objects of one-sided metaknowledge. Brauner et al. (2000) found that participants in higher hierarchical positions tend to have less adequate metaknowledge. This type of connection we term simply metaknowledge while two-sided connections we call TRAKS-metaknowledge. TRAKS-metaknowledge and metaknowledge can occur within as well as between organizational subunits (cf. Figure 2).

5. ORGANIZATIONAL KNOWLEDGE DEVELOPMENT

In their book The Knowledge-Creating Company, Nonaka and Takeuchi (1995) discuss explicit vs. implicit and declarative vs. procedural knowledge. They claim that declarative knowledge equals explicit knowledge and procedural knowledge equals implicit knowledge. Two major issues arise from this view. First, declarative knowledge can be implicit as well as explicit knowledge. Culture, for instance, is a phenomenon that can be conceived of as implicit knowledge. Most people who live in one culture are completely unaware of the taken for granted assumptions related to that culture. Knowledge about culture is hence declarative implicit knowledge. However, leaving a culture and viewing it from a foreign perspective enables (at least some) people to render (at least some) implicit knowledge into explicit knowledge. Furthermore, priming studies in cognitive psychology show that declarative knowledge can be effective without study participants having conscious awareness of the source of their knowledge (Anderson, 1995; Sternberg, 1999).

Second, there exists also explicit procedural knowledge. Skill learning comprises three stages, namely the cognitive stage, the associative stage, and the autonomous stage (Anderson, 1995). In the cognitive stage, declarative knowledge about the skill is learned. For instance, learning how to drive a stick shift car starts with declarative knowledge about the position of gears. In the associative stage, a transition from a declarative representation to a procedural representation takes place. Changing gears starts getting smoother; verbalization of declarative components is still possible, although no longer necessary. Thus, skill learning in the associative stage can be viewed as an example for explicit procedural knowledge. Only in the autonomous stage skill performance is automatic and needs no longer control through the cognitive system. The autonomous stage therefore complies with Nonaka and Takeuchi's assertion that procedural knowledge is implicit. Accordingly, procedural knowledge can be explicit as well as implicit. Table 1 illustrates the relationships between declarative, procedural, implicit, and explicit knowledge and provides descriptions derived from different references on implicit and explicit knowledge.

On the organizational level, explicit declarative knowledge is, for instance, to know that working on a specific task requires a specific tool. Explicit procedural knowledge is to know how to operate machines and furthermore to be able to teach others to do so. Implicit declarative knowledge is to know which cues indicate that a job applicant is promising without being able to verbally express them. Implicit procedural knowledge finally is to know how to deal adequately with unpleasant customers without being able to verbalize details about the action.

Organizational knowledge development can be described now as a two-way process (cf. Figure 3). First, analogous to skill learning, people in organizations learn declarative components of tasks. Through association, subtasks are interrelated and a transition from a declarative representation to a procedural representation is achieved. Through further training, procedures and processes in organizations can become autonomous and automatic. We call this process of organizational knowledge development automation of explicit knowledge.

Undoubtedly, invaluable advantages of automation are effortlessness, higher processing speed, and lack of cognitive involvement, as implicit processes do not require mental energy (Frensch, 1998). Capacities are saved for other tasks and allow e.g. working on two tasks at the same time. However, this stage implies a (potential) loss of the ability to verbalize, and moreover a loss of the ability to generate metaknowledge (Chan, 1992, in Berry & Dienes, 1993). Remaining in the automation stage for too long without reflecting details of procedures can be dangerous as e.g. new technologies can outperform old routines. Thus, the reverse process, namely the explication of implicit knowledge is essential as well. Organizational knowledge development thus faces a dilemma: On the one hand, automation is required and necessary to succeed and to perform profitably; on the other hand, due to loss of metaknowledge automation can be harming and thus explication of routines indispensable.

Although rendering implicit knowledge explicit is in accordance with Nonaka and Takeuchi (1995), we propose a strategy that differs from the knowledge spiral. In the job applicant example or the negotiation skill example mentioned above declarative resp. procedural implicit knowledge is given. To render this knowledge explicit, an external perspective is considered necessary. As it is usually difficult for an individual to adopt an external view (although Symbolic Interactionism describes the self in a similar vein; Mead, 1934/1988) external observers can provide necessary information through observing organizational processes. Again, for a successful observation metacognition is desirable and required.

As Nonaka and Takeuchi (1995) describe, in the late 1980s, Matsushita Company developed an automatic home bread-baking machine. The mechanization of the dough kneading process was a major problem. Because the skill of dough kneading is mainly implicit knowledge of bakers, an engineer became an apprentice of a master baker. She learned the skill of kneading dough and explicated the process to her colleagues in the development team so that they were able to construct an adequate prototype of the bread-baking machine. Nonaka and Takeuchi (1995) argue that what happened was a process of sharing implicit knowledge, i.e. the conversion of individual implicit knowledge to shared implicit knowledge. Using the TRAKS-model to interpret the example reveals that the engineer did not acquire implicit knowledge, but explicit procedural knowledge. Moreover, she used observation (of the baker's and of her own kneading) as a metacognitive strategy to explicate another person's implicit procedural knowledge.

6. METAKNOWLEDGE IN MANAGEMENT PROCESSES

Managing organizations, or organizing, may be seen as reflexive construction and reconstruction of social order (Ortmann, Sydow, & Windeler, 2000). Though it may not be neglected that processes of coordination and control are based on sanctions and the control of resources, they may also be described as processes involving knowledge and information (Becker, 1997). Specifically, organizing is rooted in the use of declarative and procedural metaknowledge. Therefore, we contend that management practices may be conceptualized as based on, and bringing forth, transactive knowledge systems. TRAKS, thus, are basic to innovation or knowledge creation as well as for routine management processes in organizations.

We will illustrate the latter referring to management accounting systems and practice. A basic part of management accounting is budgeting. Budgeting involves, among other things, the translation of plans into financial expressions, the negotiation between the budgeting bodies and the operating departments, the control of the budget, the investigation of variations, and the proposal of corrective action (Horngren, Bhimani, Foster, & Datar, 1999). Accountants apply declarative as well as procedural metaknowledge (Table 2). Both are necessary for the successful creation and management of a budget.

Declarative metaknowledge in budgeting comprises accountants' directories for the location of data and information required for the budget itself and for expertise about budgeting techniques. Furthermore, an experienced accountant may be expected to possess declarative metaknowledge on the quality of data from different sources, i.e. the trustworthiness of information sources, and on the relevant special interests and perspectives of the departments involved.

Procedural metaknowledge on the acquisition of knowledge in budgeting encompasses the form of the accountant's involvement in planning processes, which enables him or her to acquire first-hand data (cf. Ahrens, 1999), and the way of planning and organizing the budgeting process through the allocation of responsibilities, time schedules, data sheets, etc. to provide for timely and acceptable data. Strategies for the evaluation of knowledge involve the cross checking of data delivered by the departments, the careful checking of calculations, the awareness to the influence of special departmental perspectives and interests on the planning data delivered, etc.

Metaknowledge is implied in the budgeting or management accounting process on two levels. First, accountants in the day-to-day praxis of management accounting use metaknowledge. Though not concerned with metaknowledge, the study of Ahrens (1999) provides extensive material that demonstrates how this is achieved in the interactions between accountants and department managers. Accountants draw on metaknowledge to reflexively monitor and control their own activities or strategies of action (cf. Giddens, 1984). Second, designers of accounting systems systematically use metaknowledge on accounting when organizing accounting practices and accounting systems. Metaknowledge provides the material for organizing. As a result, operating accountants and designers of accounting systems use metaknowledge for different purposes. The former apply metaknowledge for the purpose of reflexively controlling their interactions in accounting processes. The latter employ it to design accounting systems and thus structure the field of action for the accountants and the members of the operating departments.

Referring to Wegner (1986, 1995) we argued that metaknowledge and TRAKS come into being through interaction. Consequently, systems of metaknowledge in management accounting, or in management processes in general, are the result of interaction processes, e.g., of budgeting. At the same time, not only the accountants, but also people in the operating departments with whom they interact, participate in the accounting or budgeting-specific TRAKS. Thus, TRAKS encompass shared metaknowledge. It is shared, first, among the accountants and their partners (or opponents) in the operating departments, and second, among the operating accountants and the people organizing the accounting system. Only through drawing on shared metaknowledge accounting practices like budgeting and the reflexive control of accounting systems are feasible.

7. TRAKS AND THE ORGANIZATIONAL MANAGEMENT OF METAKNOWLEDGE

Knowledge in organizations is, as pointed out previously, entirely and exclusively represented in individuals, respectively in their memories. Our model of transactive knowledge representation takes this into account. Organizations have access to their members' knowledge through the network and the interconnectedness of transactive knowledge systems (TRAKS). If two members of different organizational subunits are interconnected through TRAKS, any member of the respective subunit has potential[2] access to knowledge represented in the other subunit. Thus, organizational knowledge development through automation and explication is an important though not sufficient endeavor for managing knowledge in organizations. What needs to be done besides that is the continuous promotion of interconnectedness through TRAKS-metaknowledge between organizational subunits and their members. Through interconnectedness, supervision and location of expertise is made possible in a non-hierarchical, and hence faster and more efficient manner.

Thus, the management of metaknowledge in general, and the management of TRAKS-metaknowledge in particular can be described as a shortcut to organizational knowledge and expertise. However, it is important to note that we claim organizational knowledge management to be exclusively concerned with individuals', i.e. living cognitive systems', management of metaknowledge. Managing technical devices for storing and retrieving data, e.g. computers and their corresponding software, we term data and information management. Although it is important for contemporary companies to elaborate their data and information management and to continually improve it, and although the two systems are inseparably intertwined because technical systems are operated by human beings, it is crucial to emphasize that they also may not be confused. Different measures and different strategies have to be taken to manage the one, or the other, or both.

Furthermore, the management of metaknowledge in organizations is not a discontinuous, but a continuous task. This is true for, first, routine, day-to-day management of organizational processes; second, organizational quality management; and third, organizational innovation processes. We will now briefly discuss these three aspects of organizational knowledge management.

Management processes. As demonstrated above referring to the management accounting example, the use of metaknowledge is deeply embedded in the day-to-day practices of management. A well-developed TRAKS can further coordination in organizations through

providing the conditions for access to necessary information. While the function of information management is the organization of the provision of data and information, the main focus of knowledge management for day-to-day management praxis is the promotion of interconnectedness as a prerequisite for the development of TRAKS.

There are formal organizational structures that have the potential to improve interconnectedness of people involved in organizational processes. First, formal structures reflecting the demands of business processes are more likely to enable people especially to acquire declarative metaknowledge on the location of other people's expertise than are functional structures. Interaction is facilitated through the adaptation of formal structures to work processes. Second, the size of organizational units has an important influence on the evolution of TRAKS. Face-to-face interaction facilitates the creation of transactive knowledge systems. Organizational units too big or too complex, in contrast, inhibit this. Thus, organizational units that allow for sufficient face-to-face interaction further efficient TRAKS.

The study of Brauner et al. (2000) mentioned earlier reveals that in the R&D department in question the senior managers had insufficient metaknowledge, while the middle managers and the engineers at the lowest hierarchical level had well-developed metaknowledge. This indicates a fundamental problem for (meta-) knowledge management. Senior managers in a line organization who are detached from productive processes in their departments may lack sufficient metaknowledge concerning these processes. This severely hinders their managing the department. They may, for instance, not recognize the importance of a person's expertise when that person leaves the firm. Furthermore, not only the detachment of superiors from productive processes but also their hierarchical position may inhibit the development of TRAKS. Expertise is a source of influence for subordinates. Therefore, they are likely to at least in part protect their specialized knowledge. From the perspective of the management of metaknowledge it is important, thus, to create win/win-situations regarding the exhibition of areas of expertise. This might involve employee participation, team-based pay, or long-term contracts. Brauner et al. (2000) show that people with less well-developed metaknowledge were less satisfied with their jobs. Satisfying working conditions and trust will enhance interaction and the development of TRAKS.

Quality management. We characterize Total Quality Management (Juran, 1988) as a process of systematically applying metacognitive strategies and metaknowledge. The principle of treating errors as an opportunity to learn is procedural metaknowledge; particularly it is a strategy for acquiring knowledge. Likewise, the principle of kaizen (continuous improvement) implies procedural metaknowledge. It comprises a strategy for acquiring knowledge and, more important, a strategy for evaluating knowledge. As argued earlier, the former results in declarative knowledge, e.g., about methods of production. The latter results in new declarative metaknowledge, especially knowledge on the quality of knowledge, e.g., the quality of data from production control systems. The principle of everyone's responsibility for quality comprises, first, procedural metaknowledge as stated above; second, it comprises declarative metaknowledge, as members of the organization must know whom to inform in the case of quality problems. Furthermore, they must know where to get information about, e.g. quality standards and quality control procedures.

Finally, quality circles are an instrument for knowledge management. On the one hand, members of quality circles develop a TRAKS containing metaknowledge relevant for the improvement of quality. As the members of the quality circle are at the same time members

of other organizational units, the knowledge of the members of these units becomes accessible to the quality circle through the interconnecting of TRAKS (cf. Fig. 2). On the other hand, the knowledge and information produced in the quality circle is distributed throughout the organization via the TRAKS that its individual members share with other organizational units. Thus, in the perspective of knowledge management quality circles may be seen as the focus of a network of transactive knowledge systems.

Innovation and knowledge creation. The concept of TRAKS sheds new light on organizational innovation processes understood as knowledge creation. Nonaka and Takeuchi (1995) conceive the process of innovation as an interaction between implicit and explicit knowledge. They propose four stages of knowledge conversion, namely socialization (i.e. sharing of implicit knowledge), externalization (i.e. explication of implicit knowledge), combination (i.e. combining bodies of explicit knowledge), and internalization (i.e. converting explicit into implicit knowledge). We claim that the process of knowledge conversion may be understood better referring to the distinction between knowledge and metaknowledge and to Brauner's (in prep.) model of TRAKS.

For Nonaka and Takeuchi (1995) the process of sharing implicit knowledge is the first stage of innovation, or knowledge creation. As we argued earlier, Nonaka and Takeuchi confuse the sharing of implicit knowledge in innovation with its explication. The sharing of implicit knowledge is in our view no suitable part of innovation processes. Socialization occurs, e.g., when new members enter an organization and are implicitly introduced to values and norms as parts of the organization's culture (Schein, 1984). Another example is trial and error learning as it occurs, for instance, in a master-apprentice relationship when the apprentice learns solely by trying and feedback on the results. Particularly, no metaknowledge is involved in the sharing of implicit knowledge. No systematic development of knowledge takes place. Thus, socialization is no adequate process for organizational learning and innovation.

We have already emphasized the central importance of the metacognitive strategy of assuming an external perspective and systematically observing skilled people for the explication of implicit knowledge. This is covered by Nonaka and Takeuchi's (1995) process of externalization, i.e. the explication of private implicit knowledge. Externalization is a crucial stage in the innovation process. Relating this to knowledge management implies, first, that externalization presumes the existence of (meta-) knowledge about the location of implicit skills or implicit declarative knowledge and about their potential usefulness for the organization. Second, it alludes to the importance of systematically developing skills for observing and reflecting on other people's knowledge.

In the combination stage of knowledge creation (Nonaka & Takeuchi, 1995), different bodies of explicit knowledge are integrated to a new body of knowledge as a prerequisite for product or process innovation. Explicated, i.e. formerly implicit, knowledge may be involved. In this stage, too, declarative metaknowledge is essential. Furthermore, metacognitive strategies useful for the combination process may encompass the development of a common language if the stocks of knowledge involved are very diverse, or the development of specific rules like, e.g. "no taboos".

The fourth stage mentioned by Nonaka and Takeuchi (1995) is internalization, the conversion of new explicit knowledge into implicit knowledge. However, as in the case of socialization, the conceptualization of this stage raises some issues. Internalization can only involve the

automation of explicit knowledge related to new processes as the result of an innovation. Thus, it can only concern the users of a new process, tool, or product. We have mentioned the dilemma that is connected to this automation of explicit knowledge in the light of knowledge management. On the one hand, automation contributes to greater efficiency; on the other hand it implies a potential loss of knowledge because the knowledge is either not accessible at all or only accessible through a new process of explication, hence entailing costs. Nonaka and Takeuchi, however, seem to imply that the internalization occurs for the competences of organizing the innovation process itself. These competences are, however, metaknowledge and as such explicit knowledge by definition.

To conclude, the Nonaka and Takeuchi (1995) model of innovation as knowledge creation may be specified referring to the concept of TRAKS (Brauner, in prep.). In the light of a more adequate distinction between implicit and explicit knowledge the socialization stage should not be viewed as part of innovation and knowledge management, and the internalization stage appears to be problematic for knowledge management. The stages of externalization and combination are specified through the distinction between knowledge and metaknowledge.

Finally, implications for development teams may be derived from the TRAKS model: First, the composition of a development team requires declarative and procedural metaknowledge of the supervising managers. They must have knowledge, or access to information, about potential qualified members of a team, i.e. about their expertise and its quality (Brauner, 2001). Second, the development team must, on the one hand, develop an internal TRAKS that enables its members to access the other members' knowledge and set up an adequate division of subtasks (cf. Olivera & Argote, 1999). Knowledge management then has the task of developing a culture of perspective-taking and accepting multiple views. Trainings in perspective-taking can further this. However, Moreland and Myaskovsky (2000) show that there is also a more direct way to the development of metaknowledge, respectively transactive memory, through providing group members with listings of other member's areas of expertise. On the other hand, the development team must acquire or already have metaknowledge about potentially useful knowledge of non-members. Existing TRAKS in which the members of the development team are involved can be utilized for this purpose.

8. CONCLUSIONS

The key question of responsibility accounting, Horngren et al. (1999) state, is, "Who is the best informed? Put another way, Who is the person who can tell us the most about the specific item in question, regardless of that person's ability to exert personal control?" (p. 508). This kind of question arises not only in the context of management accounting, but for management processes in general. Metaknowledge is the key to access scattered expertise in organizations in an efficient and practical way. This is true for routine management activities, as well as for quality management and innovation.

In science fiction, everything is bigger and brighter than in real life. In many Star Trek episodes Scotty states that he cannot change the laws of physics; accordingly we must add that it is not easy to change the laws of micro-politics. However, as today's science fiction may be tomorrow's science fact, we hope that the management of metaknowledge will help find shortcuts to scattered expertise in organizations.

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Footnotes

[1] From a social constructivist point of view the term shared knowledge is not appropriate. Constructivism claims that two independent cognitive systems will never achieve identical constructions of the world. However, to avoid solipsism, the less radical constructivist branch presumes that at least viability, i.e. compatible fit, can be achieved (cf. Maturana & Varela, 1992).

[2] However, organizational reality shows that potential access does not necessarily mean actual access (Becker, 1997).

Table 1

Interrelations between declarative, procedural, implicit and explicit knowledge

	Explicit Knowledge	**Implicit Knowledge**
Declarative Knowledge	• Knowing That (Ryle, 1969) • Contains conscious knowledge about the world (Anderson, 1995) • Cognitive stage of task performance (Anderson, 1995) • Verbalization possible and necessary (Anderson, 1995) • Metaknowledge available	• No conscious awareness, implicitly acquired, incidental learning (Berry & Dienes, 1993) • Priming possible, although no knowledge about source of information • Less manipulable, robustness (Berry & Dienes, 1993) • Representation rather in examples, more context bound, no transfer (Berry & Dienes, 1993) • No metaknowledge available (Chan, 1992, in Berry & Dienes, 1993)
Procedural Knowledge	• Knowing How (Ryle, 1969) • Associative stage of task performance (Anderson, 1995) • Transition from declarative to procedural representation (Anderson, 1995) • Verbalization still possible although not necessary (Anderson, 1995) • Metaknowledge available	• No cognitive involvement needed • Non-intentional, automatic, lack of control, effortless (Frensch, 1998) • Autonomous stage of task performance (Anderson, 1995) • Potential loss of ability for verbal description (Anderson, 1998) • No metaknowledge available

Table 2

Knowledge and metaknowledge in budgeting

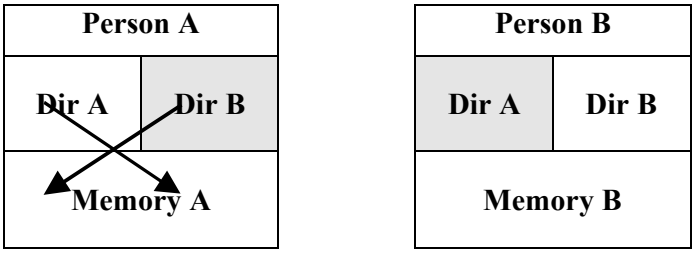
	Knowledge	**Metaknowledge**
Declarative	• Data required for budgeting, e.g., costs of material and labor, production plans • Knowledge about methods of budgeting	• Metaknowledge about location of information about the budgeting process • Metaknowledge about location of data required for budgeting • Metaknowledge about quality of data • Metaknowledge about trustworthiness of sources • Metaknowledge about necessity of considering operating departments' interests and perspectives influencing quality of data
Procedural	• Knowledge about procedures of planning and budgeting • Skills for reading and understanding budgets etc. • Negotiation skills	• Metaknowledge about planning the budgeting process (who, when, what?) • Metaknowledge about strategies of interactive involvement in operating department's planning processes to acquire data • Metaknowledge about developing forms for operating department's planning processes • Cross-checking data delivered by operating departments • Cross-checking own calculations • Metaknowledge about coping with micro-political constellations

Figure Captions

Figure 1. Wegner's (1995) model of transactive memory

Figure 2. Interconnections of Transactive Knowledge Systems (TRAKS) in an organization

Figure 3. Organizational knowledge development and learning (solid arrows: process of automation; dotted arrows: process of explication)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Dir A
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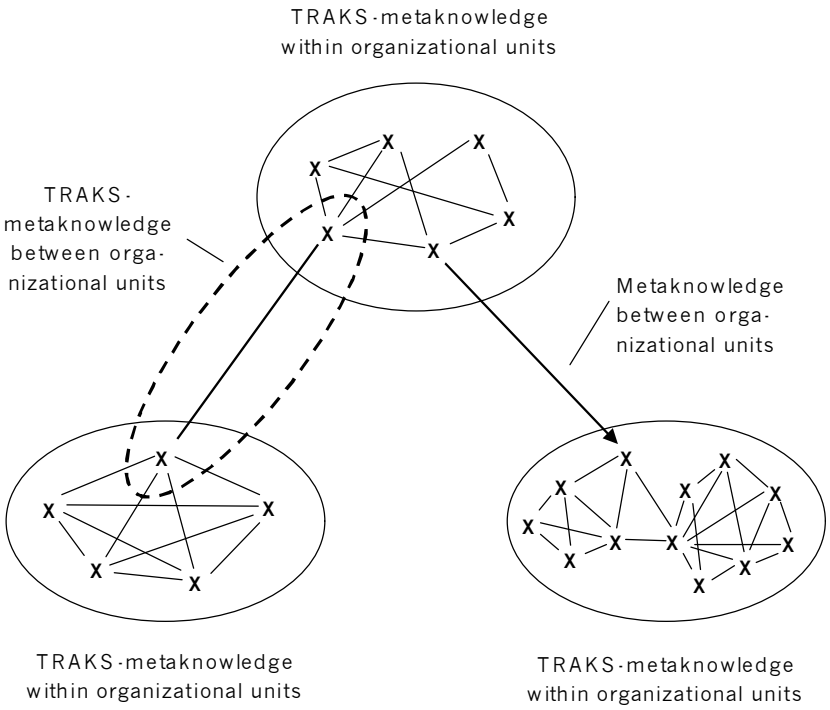
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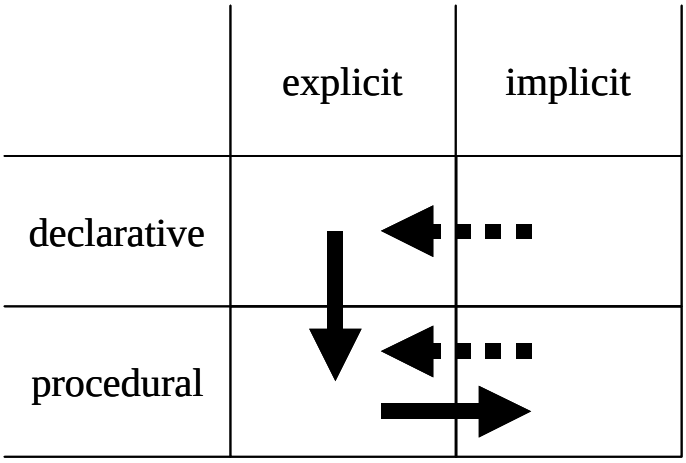
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