# Knowledge Integration and the Meaning of Boundary Activities[1]

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## Abstract

Knowledge integration is a critical topic in current knowledge management research and practice. Research on this topic focuses primarily on how knowledge is integrated within a work setting. A less researched area is knowledge integration between different work groups, which is the focus of this paper. The paper presents two intensive case studies—one permanent work setting and one temporary (project) work setting—which were studied using a practice-based perspective. The purpose is to describe and explain how knowledge is integrated between different work groups and we address why is it that boundary activities work or break in knowledge integration. A main result of the study is that knowledge integration in the two cases was more complicated than the literature suggests. Differences in knowledge and organizational landscapes made knowledge integration a challenging task. Both differences and similarities were found between the two cases. Differences were seen in the use of boundary spanning activities and boundary objects. Similarities that were found were, for example, organizational structures and mechanisms, i.e. purposes, rules, and infrastructures, which facilitated the integration of knowledge or could function as obstacles and impediments.

## 1. Introduction

Organizations spend a lot of resources on managing knowledge repositories and knowledge flows, whether manual or computerized. However, knowledge management (KM) can be a waste of time, energy and money if organizations not are successful in knowledge mediation and use. We address mediation with a focus on what happens when mediated information needs to be interpreted and converted to knowledge. We study how different groups that must integrate knowledge are actually integrating knowledge. Knowledge integration is a critical topic in current KM research and practice (Edwards et al., 2003). Research on this topic focuses primarily on how knowledge can be integrated within a work setting, for example, within a "community-of-practice". A less researched topic is "knowledge integration between different work groups" (Scarbrough et al., 2004; Bechky, 2003), which is the focus of this paper.

Researchers have acknowledged the importance of boundary spanning activities and boundary objects (Star, 1989; Star & Griesemer, 1989). Based on the literature, it can be hypothesized that boundary spanning activities and boundary objects play a critical role in knowledge

sharing and transfer between a focal project or work group and other projects or work groups and the "historical" and contextual environment. But, our understanding of how knowledge "flows" across project or work group boundaries is limited and empirical research is needed (Newell & Huang, 2003).

Knowledge is a fuzzy concept having different meanings and connotations. We will not enter the "knowledge discussion", but instead use one current perspective on knowledge and KM. In the KM literature two main perspectives on knowledge and KM are voiced (Gherardi, 2000; Hayes & Walsham, 2003; Swan 2003). In the first perspective, which Swan calls "the engineering perspective", Hayes & Walsham "the content perspective", and Carlsson et al. (1996) the "object perspective", knowledge is perceived as an object that can be codified, stored, and distributed. This means that knowledge can in part be decontextualized, codified and transferred from one place to another place and from one person to another person. The other perspective, which Swan (2003) calls "the community perspective", emphasizes social relationships as knowledge development structures. The perspective acknowledges the limits of knowledge codification and stresses that knowledge is situated in people's heads, but as a result of social interactions also in a group of people (community) who share a common interest. Hayes & Walsham (2003) call this perspective "the relational perspective". It brings out knowledge as a context dependent process. Some scholars criticize the knowledge object view and argue for a knowing view (Blackler, 1995; Gherardi, 2000). Knowing represents a process of acquiring knowledge, which is situated and relational. Spender (2003) argues that an organization is an instrument for integrating knowledge and activities (doing). We will use the concept of practice as a theoretical lens because it enables us to understand the integration of knowledge as practice connecting "knowing" with "doing" (Gherardi, 2000). Gherardi (2000) describes it as: "*practice is both our production of the world and the result of this process. It is always the product of specific historical conditions resulting from previous practice and transformed into present practice*"

In this article we adopt the practice-based perspective and accordingly that knowledge is created and used in "continuous" knowing processes. At the same time, we perceive knowledge as both an input and a result in these processes. Since every knowledge process is connected to a context, knowledge can not be treated as an independent object, it is a temporary product which is connected to the current context and processes as well as to historical processes and contexts.

One important feature in knowing processes is knowledge integration. We use the concept integration as a general word for the knowledge flow process between groups and individuals which are members of different working contexts. The term integration is adopted from Grant (1996) who writes:

> "If Grant and Spender wish to write a joint paper together, efficiency is maximized not by Grant learning everything that Spender knows (and vice versa), but by establishing a mode of interaction such that Grant's knowledge of economics is integrated with Spender's knowledge of philosophy, psychology and technology, while minimizing the time spent transferring knowledge between them." (Grant, 1996).

This means that knowledge integration is about cooperation between different practices, i.e. how knowledge which is created in one working context is used by another. As said above our focus is on the boundaries between the groups where knowledge is integrated.

Two different work practices are studied. The first is a permanent work setting where knowledge integration is "continuous" and aims at learning from the work groups the focal work group interacts with. The other study is a project (temporary organization) where knowledge integration aims at learning from one project to another as well as to learn from the project group's environment. Hence, the studied phenomenon is the same for the two practices: inter work group knowledge integration with a focus on boundary activities. We intend to identify similarities and differences in how knowledge integration is done in the two different practices.

Our study is influenced by recent thinking in organization studies, where studies are problem-driven and oriented toward events unfolding in the world (Davis & Marquis, 2005). The focus is on social mechanisms which are "sometimes-true theories" providing "an intermediary level of analysis in-between pure description and storytelling, on the one hand, and universal social laws, on the other" (Hedström & Swedberg, 1998). Said Davis and Marquis: "If a regression tells us about a relation between two variables—for instance, if you wind a watch it will keep running—mechanisms pry the back off the watch and show *how*. Mechanisms describe "a set of interacting parts—an assembly of elements producing an effect not inherent in any one of them. A mechanism is not so much about 'nuts and bolts' as about 'cogs and wheels' . . . —the wheelwork or agency by which an effect is produced" (Hernes 1998, p.

74).” (Davis & Marquis, 2005). Problem-driven research “…is distinguished by its orientation toward explaining events in the world, beginning with the question, `Why is it that …?´” (Schoonhoven et al., 2005). In our case: why is it that boundary activities work or break in knowledge integration?

The remainder of the paper is organized as follows. In Section 2 we discuss the two different work practices studied. We then address knowledge integration, boundaries and mediating tools. Section 4 presents the research approach and the two case organizations.  In Section 5 the cases are presented and analyzed. Section 6 presents conclusions and suggests further research.

## 2. Permanent and Temporary Work Practices

Permanent and continuous work practices have other characteristics than temporary work practices. We can expect differences in how knowledge is integrated and the boundary spanning activities taking place. We do not look at the two different organizational forms as such, but rather how activities are organized depending on the characteristics of the organizational form and how a specific activity differs between the two forms. The verb organizing is thus in focus instead of the noun organization. Permanent and continuous work practices have mechanisms that facilitate the integration of knowledge. These can have been designed or can have emerged naturally. The permanent work practice is considered “eternal”, where the systems and mechanisms that are designed and built are planned to exist for the foreseeable future (Ekstedt et al., 1999). A specific work practice is part of a larger system and needs to interact with the surrounding organizational context.

Projects have until recent years been understood as distinct and isolated activities that can be designed and used, independent of the surrounding organizational context (Blomquist & Packendorff, 1998; Blomberg, 1998, Partington, 1996). The project is limited in time, has a unique goal set in the beginning of the project and a unique set of people working within the project. After the completion of the project, the project members continue to new tasks and new projects. These characteristics affect the integration of knowledge. The memory of the temporary work practice is more of a network memory, where the project members are part of a larger knowledge collectivity rather than a knowledge community (Lindkvist, 2005). The temporary work practice has not the same supporting structures and routines as the permanent work practice. This in turn makes the knowledge more individual, and it is not “built into” the

organizational memory (Lundin & Söderlund, 1998). The strong focus on goals and tasks lead to a learning that is primarily local (Tell & Söderlund, 2001). Another factor affecting the knowledge integration is the difficulties in establishing deeper relationships, since the time is limited which in turn affects the willingness and possibilities to integrate knowledge between individuals and groups (Berggren & Lindkvist, 2001). However, to minimize the time of the project it is preferable if actors learn from their previous mistakes and draw from the experiences they have from historical projects. Even if obstacles are present there are possibilities for integrating knowledge from the context of the project (Brady & Davis, 2004; Scarbrough et al., 2004).

## 3. Knowledge Integration, Boundaries, and Mediating Tools

Kalling & Styhre (2003) argue that "*knowledge is always articulated, expressed, and brought into being trough various practices.*" Knowledge is understood as embedded in the everyday practice. The organization learning literature emphasizes the concept of practice in an attempt to understand the learning and sharing of knowledge in organizations. In recent years the concept of practice has been used as an analytical tool within the KM field. Kalling & Styhre (2003:18) argue that "*the concept of practice enables the analysis of how knowledge is employed and developed in organizations without reducing it to the level of the individual co-worker, and without turning it into some structural quality of the firm.*"

Carlile (2004) is interested in the boundaries that exist *between* different groups, when knowledge is integrated. Depending on the characteristics of the boundaries, in the shape of difference, dependence and novelty, the ability to share and assess knowledge varies (Carlile, 2004). Difference refers to amount of knowledge based on experience (expert versus novice) and type of knowledge (different specialties). Dependence between groups refers to how dependent of each other the groups are, when it comes to meet common goals (e.g. different stations in an assembly line) and novelty is new needs that create new requirements on different actors (e.g. changes in customer needs). Accordingly, the boundaries between groups are a challenge for the organization, but by means of different boundary spanning activities also a source wherefrom knowledge can be created.

Carlile (2004) uses three concepts to emphasize different types of boundaries based on degrees of complexity: *syntactic*, *semantic* and *pragmatic*. These three boundary types

represent three different processes of boundary spanning activities: *transfer*, *translate* and *transform*.

*Syntactic* boundaries are found between groups where differences and dependencies are known and in forehand specified. Knowledge can then be *transferred* and integrated without interpretation. Requirements for this type of integration are that the groups that are participating must have a common language, or a common syntax, which makes the meaning of integrated knowledge same for sender and receiver and that the conditions are stable.

If these requirements are missing, i.e. if novelties arise making differences and dependencies unclear, knowledge integration necessitates an intermediate step, an interpretation process, Carlile uses the word *translation* and define the boundary as *semantic*. Translation occurs when sender and receiver have different knowledge and are "living" in different contexts which make the shared language, or syntax, inadequate, but differences and dependencies are identified and the groups understand the consequences of them without changes in their domain-specific knowledge.

The third concept, *transformation*, is the most complex form of integration and is connected to *pragmatic* boundaries. It occurs when understanding differences in knowledge and context also is insufficient and there must be a deeper understanding of how changes at one part will affect the other. The knowledge can not be separated from practice and the sender and the receiver have to negotiate and change their own domain-specific knowledge in a way that supports the integration.

From this discussion we conclude that boundaries may be classified in terms of complexity. A fundamental aspect in knowledge integration between work groups is the capability to create a *common understanding*. Furthermore, for knowledge integration across boundaries to take place there must be a boundary mediator, or carrier, of knowledge. Next we discuss more about common understanding and *mediating tools* where the two types of possible mediators (*boundary objects* and *brokers*) are in focus.

### 3.1. Common understanding

Scholars discuss common understanding as a prerequisite for knowledge integration. Common knowledge between the members of the organization is needed in the sharing and

integration of knowledge (Grant, 1996). This common knowledge rests on common language, other forms of symbolic conversation, commonality of specialized knowledge, shared meaning and recognition of individual knowledge domains (Grant, 1996). The focus on common language, routines and structure should be complemented with the possibility to facilitate innovation and provoke continuous learning (Kreiner, 2002a). Kreiner (2002b) calls this a ”*double-sided concern*”, to be able to cope with both the existing knowledge and to create new. These two processes are not separate from each other, but rather entangled and intertwined (Kalling & Styhre (2003). To accomplish this there is a need for a balance between on one side the need for a common knowledge base and on the other side the need for different knowledge bases (Kreiner, 2002a). Focus on a common language, routines and structures need to be complemented with the possibility to facilitate innovation and continuous learning through the combination of *different* knowledge bases (Kreiner, 2002a), where the common knowledge base is small. With the starting point that the knowledge base varies it is possible to understand that there are differences in the boundaries between different communities or projects which affects the knowledge integration.

## 3.2. Mediating tools

In the discussions about how knowledge may be integrated across boundaries, different types of mediators are defined. Mediation and mediating tools are part of the boundary spanning activities. Depending on the extent of common knowledge Boland & Tenkasi (1995) distinguish between *perspective making* and *perspective taking*. Perspective making is the creation of own language, or perspective, within a group, whereas perspective taking refers to the sharing of perspective across group boundaries.

Wenger (1998) points out two types of connections between boundaries which can promote perspective taking: *boundary object* and *brokering*. The concept *boundary object* comes from Star (1989) and Star & Griesemer (1989). From their point of view boundary objects are concrete or abstract "bridges" allowing groups with different perspectives and aims to contribute to a more comprehensive objective. Star (1989) describes boundary objects as something wherefrom it is possible to establish a common context. Examples of boundary objects are maps, repositories and standardized forms. These boundary objects can be compared to the intermediaries "text and inscriptions" and "artifacts" that Gherardi & Nicolini (2000) use to understand the sharing of knowledge that is taking place. Wenger defines boundary object as a reification that uses, or can be seen, from different needs and

perspective, for example, an information system. When Fischer (2001) discusses learning between different Communities of Practices, he points out that the boundary objects must mediate a shared frame of reference to all parties involved. A single individual or a group of individuals just have one part of the interpretation control for the boundary object and just one part of the knowledge that is needed for solving a common problem.

The other type of connection types, *brokers*, refers to human beings who have a kind of multi-membership and who have working roles which comprise transformation of knowledge between groups. Brokers thus have multiple memberships in order to translate, coordinate, and align between the perspectives (and genres) of the different practices. (Wenger, 1998). Brokering is a connection made by a person with memberships in multiple practices; brokers "introduce elements of one practice into another" (ibid.). A good broker opens up new possibilities for sense making and managers at varying levels often have this brokering as a work task. The most fundamental way to mediate is the use of language. Language lets us understand each other and the practice that we are part of (Gherardi, 2000). Language gives the tools by which knowledge can be articulated both in speech and writing.

To summarize: We will address our research question—why is it that boundary activities work or break in knowledge integration—by studying knowledge integration in two different organizing contexts: a permanent and a temporary. Within these contexts knowledge is integrated by transfer, translation or transformation of knowledge. Knowledge integration is affected by the level of common knowledge and is accomplished by different mediating tools, where we focus on boundary objects and brokers.

## 4. Research Approach and the Two Knowledge Integration Cases

The paper is based on two intensive longitudinal studies of knowledge integration in two different work practices: one public medical service—the Health care case being a permanent work practice—and one technology and engineering company—the Gamma case being a temporary work practice. The empirical data is qualitative. It was collected by two persons having the same knowledge perspective and theoretical foundation. The Health care case was conducted between January 2003 and November 2003 and the Gamma-case was done between May 2002 and September 2003.

In both cases interviews, observations and document studies were accomplished. In the health care case one laboratory and four of its customer units were chosen and in the Gamma case one project with its connections to the environment was focused (the cases are more thoroughly described in the next section).

All interviews were of semi-structured nature, using the methodology of updating the interview guide, as argued by Taylor & Bogdan (1984). The interviews, in total 45 interviews, lasted between 45 and 120 minutes during which notes were taken. The interviews were tape recorded and. transcribed. The transcriptions or synthesis of them were checked by the interviewees (c.f. Merriam, 1994; Bryman, 2002). The questions addressed, for example, how the work was accomplished, how problems and difficulties in the work process were dealt with, how participants searched knowledge and whom they communicated with. To increase the researchers' understanding and enhance the reliability and credibility observations were also made, in total close to 40 hours. Each case was analyzed in three steps with an interpretative approach and then an interpretative comparative analysis was made. The material was read and compared to theory, citations taken, highlighting the findings, and finally the theories were further developed based on the findings.

## 4.1. The Health care case

This study organization, a county council in Sweden, serves about 328 000 citizens and consists of three hospitals and a number of related primary care centers. For this study a microbiology laboratory and four of its customer units were chosen. The overall purpose in health care service, i.e. "with available resources give patients best possible services", leads to a great need for knowledge integration between different units. The microbiology laboratory is located at one of the hospitals and is a county comprehensive specialty diagnosing diseases caused by bacteria, viruses, fungi, parasites, and immunological reactions. Two of the four studied customers are primary care units and the other two customers are hospital wards. In the laboratory, two observations and two interviews (laboratory instructor and laboratory physician) were carried out. The observations consisted of participating in laboratory technicians' ongoing analysis work. The customer interviews were done with two to five individuals (physicians, nurses, local laboratory technicians and assistant nurse) from each unit, and focused on order of analysis and interpretation of laboratory reports. Furthermore documents like routine descriptions and specimen handling instructions were studied. The

main communication means between the laboratory and its customers is a paper-based information system (paper referrals and paper laboratory reports).

The studied work process begins when a customer writes a referral, takes a specimen and sends the referral together with the specimen to the laboratory. The referral must be supplied with information, for example, patient data, the analysis choice, specimen material and details about where the specimen was taken. In most cases, there must be some information about diagnosis and other facts about suspected findings. From this information, the laboratory personnel select relevant methods for analyzing the specimen. The laboratory tries to elicit all the necessary information through predefined fields and checkboxes, but the study showed many examples where the customers gave insufficient or wrong information. For example, if the referral does not include information about how deep an ulcer is, some important bacteria may be overlooked.

The specimens that are sent to the laboratory can be all types of body fluids or secretions. To perform an analysis, the laboratory must get specimens that are taken correctly, but our study showed examples where the specimens were taken incorrectly or were unsuitable. When the analysis is finalized, the laboratory sends the laboratory report to the customer. This report may consist of preprinted text telling the customer what the analysis has showed, or numbers (measurements) together with a short interpretation guideline. If the preprinted alternatives do not cover the analysis result, laboratory personnel may write an adjusted answer or explanation. The customer receives the laboratory report and makes an interpretation of it.

If customers have questions about specimen taking or specimen handling they can search information in specimen handling instructions. These instructions are, since summer 2001, published on the county council's intranet and are "constantly" updated. If there are more extensive changes, the laboratory also publishes news on a specific intranet site. Furthermore, there are persons at the laboratory, a laboratory instructor and some physicians, that continuously shall inform customers about microbiology analyses.

### 4.2. The Gamma-project case

The Gamma-project was part of a permanent organization, MillCorp. MillCorp is a global technology and engineering company. The company offers customers new rolling mill automation systems, and upgraded customers' existing systems. At the time of the study

MillCorp had 90 employees and about 40 projects were under way in different stages. Most of the employees had work for 20-25 years at MillCorp. MillCorp can be understood as a functional matrix organizational design. However, MillCorp can also be understood as a project-intensive organization in that most of its activities are executed within different projects.

The purpose of the Gamma-project was to modernize certain parts of a rolling mill. The first stage, the Beta-project, was already finished, and the customer had decided to proceed with a second stage, the Gamma-project. MillCorp was responsible for both projects. The commissioning for both projects was to replace the existing control system with a new two-stage improvement of the very same type. The submission of both orders was done at the same time, as required by the customer. Between the two projects the customer also wanted an additional submission of an order from MillCorp, where technical specifications were included and where an additional discussion of the construction took place.

During the first six months of the Gamma-project, the project group of MillCorp consisted of four people, where after four consultants were allocated to the project due to a shortage of personnel in MillCorp. After the official start-up, the project proceeded with the design phase. During the first phase of the project, the basic design documentation from the sales phase was handed over to the project manager. Due to other projects taking place simultaneously, the documentation was shared in informal meetings between the sales and project managers. However, the documentation had some shortcomings because the persons responsible for the submission of the Gamma-order did not have all the required knowledge about the difficulties with the hydraulic issues, although at the time of the first bid phase they thought they had. However, the relationship with the customer was in particular facilitated through the contact with the lead engineer, who had been active in the Beta-project and had therefore established relations with the customer and his project team.

The hydraulic issue was a challenge for the whole project and affected many other work issues. However, it was mainly the developer who worked with the hydraulics, although he had frequent contact with the lead engineer. At the beginning of the Gamma-project, the project team insisted the original supplier of the hydraulic system should be a consultant to the project, as they had knowledge that was needed in the project. According to the project manager, the project team probably had not taken into consideration certain technical issues

without the supplier's input. During the project, problems occurred that were hard to handle without input from actors within MillCorp (but outside the project team). Some of these problems occurred during the simulations and the tests of the hydraulic system. A demand from the customer was that practical tests also be done at the site. The project team agreed, and during the execution of the project two additional tests were also made. The practical tests helped to create new knowledge about the issues that could not be captured by the simulations. Problems occurring during testing at the site were then tested further at MillCorp. In order to handle the deviations during the simulations and practical tests, contact was made to experts within MillCorp with knowledge about automation technique.

During the project the project team could rely on standards and tools when developing the automation system. These standards and tools had been developed in previous projects, but they were continuously re-developed in order to fit the projects. Each functional unit had its standards and tools. In order to be able to use them the project team had to translate and transform them so that they fitted the particular customer requirement.

Besides the individual work the project team had formal and informal meetings. These were held at regular intervals. In the formal meetings, especially customer meetings, questions often arose regarding the structure of the system and the content of the contract. Problems in opinions were often handled after the meetings, where the project manager or lead engineer had to inquire and interpret what had actually been promised and create a shared language. Communication with the sales manager and the different suppliers and consultants was therefore crucial. The informal meetings were facilitated by the open-plan office, where it was easy to ask a quick question, for example, on the way to the photocopier.

## 5. The Cases: Analysis and Discussion

In the two cases we studied knowledge integration in two different work settings. In this section we focus on why knowledge integration (processes) worked or broke in the two cases.

### 5.1. The Health care case

### 5.1.1. Boundaries

Even if microbiological analyses are, for the majority of the customers just a small part of their total work activities, results from the analyses may be very important for diagnosis and

patient treatment. The ordering–answering process contains a number of boundary spanning activities that need to be fulfilled if knowledge integration shall be successful, and accordingly there are several examples of activities that can fail or cause unnecessary troubles. Specimens can be taken in the wrong kind of test tubes or be handled in the wrong way, referrals can be without relevant information which affects the analysis and in turn the laboratory reports and the laboratory reports may contain information that the customers have difficult to interpret.

As discussed in Section 3, boundaries where knowledge integration between groups takes place can be seen as three types: *syntactic*, *semantic* and *pragmatic* (Carlile, 2004). There is a clear *difference* in domain-specific knowledge between the microbiology laboratory and the customers. The *dependency* between the laboratory and its customers is considerable. The laboratory's existence is based on the analyses they perform and the customers need the laboratory's help in diagnose and treatment work. The more *difference* and higher *dependency*, the more difficult it is to integrate knowledge (Carlile, 2004).

The *syntactic* boundary is the most uncomplicated boundary type and knowledge can be *transferred* if the groups have a common and stable lexicon (Carlile, 2004). If the boundary between the laboratory and its customers was syntactic, knowledge integration could be accomplished by access to each others databases, i.e. laboratory could have access to case records and customers to the laboratory's production system. Apart from the secrecy rules regulating this type of access in the health care sector, our study shows that the integration will be even more problematic with such a procedure. Case records and the laboratory's production system contain detailed and internal information having no relevance for other groups. With the receiving groups' needs in mind, irrespective if we take a laboratory or a customer perspective, an evaluation and a synthesis must be accomplished before integration can take place. The groups have a common medical language, but well-defined syntaxes for the evaluation are missing and it can be difficult for the customers to decide what information is relevant for the laboratory and vice versa. Following Carlile, this means that the boundary is more complicated than a *syntactic* boundary and the simplest form of integration, i.e. *transferring*, will not be successful unless some actions will be taken.

If the referral is provided with relevant information and the laboratory personnel can interpret it, if the sample is taken and handled in a proper way, and if the laboratory can formulate a

report that customers can assimilate, then the boundary can be seen as *semantic*. Knowledge integration in a semantic boundary is called *translation* (Carlile, 2004). In this case, it is not only a simple transferring of information but also an interpretation requiring awareness of differences between the groups' contexts. If this translation shall succeed, the knowledge must be stable for both groups even when novelties arise. At the laboratory there are "continuous" changes in analysis offers and methods which they must inform about internally and externally. This might lead to a need for a change in the customers' domain knowledge, depending on their previous knowledge. The customers, varying both in specialty and occupational groups, are affected by changes that may affect the laboratory's work. The customers may, for example, require new types of analysis. Hence, the laboratory might also need to change its domain knowledge. These quite frequent changes indicate that the boundaries often are more *pragmatic* than *semantic* and that *translation* of knowledge will not always be successful. When a boundary is pragmatic, it is not enough to understand the differences between groups; the groups must also be prepared to change their own knowledge (Carlile, 2004). For the laboratory and its customers, this will mean that they must be successful in informing each other about what is going on in different specialties and they must be open for negotiations about how to adjust their practices.

## 5.1.2. Common knowledge

Through education and experience a common medical language has been developed which can be seen in manuals and work descriptions. In the laboratory and in the customers different internal working languages could be identified. Several examples of situations when laboratory personnel were unable to assimilate information on the referral without consulting colleagues, physicians or medical dictionaries were identified. In the same way, some nurses said "The laboratory reports can be difficult to interpret." Accordingly, there exist a common language, but this language is not enough to cover all knowledge integration needs.

The importance to understand each others perspectives is emphasized by several authors (e.g. Grant, 1996). To a certain degree this understanding exists in the different health care units, because all personnel have medical education and they all work in the same organization. However, some individuals, or occupational groups, seem to have a better understanding of microbiology analysis than others, and these seem also to have a better capacity as sender and receiver of knowledge in this specific area.

### 5.1.3. Mediating tools: boundary objects and brokers

We view boundary objects and brokers as mediators of knowledge. They carry knowledge in the boundary and thus they play an important role in the knowledge integration process. In the health care case we identified three main boundary objects. *Referrals* since they are a kind of communication document between the customers and the laboratory. Some fields on the referral are easy for the customer to interpret, e.g. where to specify concrete facts about the patient, while others are more demanding, e.g. fields which shall contain clinical data, diagnosis and expected laboratory findings. The formal rules say that all ordering shall be done by a physician, but they often leave the writing of the referral to nurses or other personnel. In one of the units some referrals were written by the local laboratory technicians, and they had no access to the patient record system, which means that they could not provide the referral with all the relevant information.

Another type of boundary object is the *laboratory reports* sent back to the customers. Physicians shall interpret the reports, but in all the studied units, nurses make the first interpretation and signal the physicians if there are some acute actions that must be taken. The laboratory is creating the reports with physicians' medical knowledge and responsibility in mind. When nurses handle the reports they must obtain this knowledge, but in some cases, the nurses had interpretation difficulties.

The third type of boundary object is *instructions* for specimen taking and specimen handling. Only two of the customers interviewed said that they use the intranet for this purpose. The other respondents use an old version of the instructions, which is published in book form— last updated 1994. This means that it is a considerable risk that instruction changes will be missed.

Individuals working as *brokers* can be seen both at the laboratory and at the customers units. In the laboratory, the physicians and a laboratory technician who is employed as instructor have these roles since their work tasks comprise informing customers and answering their queries. The instructor is known by the customers' local laboratory technicians, but not by other occupational groups. The laboratory physicians are more widely known, but several of the customers say that they hardly ever spoke to them. The most mentioned name is instead one of the secretaries at the laboratory, because she is the first person they speak to when they call the laboratory. She often is able to answer customer queries. On the customer sides, some

individuals with more knowledge about microbiological analyses than others are identified. Their extra knowledge comes from special education, special interest or special work tasks. These customer brokers spread their knowledge in their work groups, but they are not known or used as resources by the laboratory.

## 5.2. The Gamma-case

### 5.2.1. Boundaries

The Gamma-case showed that there was a need for boundary activities between the members of the project and the context of the project in order to enhance the understanding of the problems and difficulties to be handled and for the integration of knowledge. There were both a need for boundary spanning activities between the project and its intra-organizational context are (permanent organization and parallel projects) and between the project and its inter-organizational context (customers, consultants, sub-constructors etc.).

When it comes to the boundary spanning activities between the project and its intra-organizational context it was difficult to analyze whether the knowledge that was integrated was mediated from the permanent organization or parallel projects. There existed dependencies and the knowledge used were to a high degree similar. There was a need for all three boundary activities: *transfer*, *translation*, and *transformation*. The interactions with actors within the same community within the organization were mainly about *syntactic* boundaries, where there existed a similar knowledge base between the interacting actors. The knowledge could be *transferred* through the *routines and rules* (standards, drawings etc.), which had been institutionalized in MillCorp. The different project members interacted to a high degree with members from the same community (*read*: their own departments) in order to integrate knowledge. The project members were hence part of different practices; within the project they were part of a knowledge collectivity, but when they were participating in boundary spanning activities they were part of a knowledge community. There were established *routines and rules* within each function, even though it was a project intensive organization.

Although they were part of a knowledge community it was both about relying on networking and on organizational memory. When it was about a *syntactic* boundary the project members could rely on an organizational memory, created from the institutionalized knowledge.

However, the Gamma-project also needed to interact with actors outside the project in order to solve unique problems. In these cases the boundaries was rather *semantic* since the knowledge base was different and there was a need for *perspective taking* in order to integrate knowledge. Establishing a *common language* was a means to accomplish this. The project members then could rely on their network and knew who to contact in order to solve the problem. The managing of the unique problems was often characterized by a need for an awareness of differences in contexts between the interacting actors. There was a need for *translation* of the knowledge before it could be integrated in the project.

The project also needed to interact with the external environment (i.e. costumers, consultants, etc.). These boundaries were either *semantic* or *pragmatic* (differences in knowledge but less dependency). When the project members integrated knowledge from their external environment they interacted with communities with other knowledge bases. Interactions with external consultants were of a pragmatic character due to the novelty of the technology (of the hydraulic drives). The novelty made it necessary for the project members to make sense of the ideas and knowledge of the consultants. There was a need for a creation of a shared language and interpretation. As Carlile (2004) points out the dependencies between parties facilitate knowledge integration. Even if the dependencies between the project team and the customer were quite low in the beginning it tightened during the course of the project. As the relationship developed the boundaries went from being *pragmatic* to *semantic*, and in the end even *syntactic*. The analysis shows that the nature of knowledge integration was dependent on where in the project cycle the project was.

Knowledge integration, both intra- and inter-organizational, was done differently depending on the situation at hand. Although there were differences in knowledge the well-connectedness of knowledge bases facilitated the knowledge integration. Even if the case shows the possibilities of integrating knowledge there were also difficulties. There was occasionally a belief that the boundary was *syntactic* and that it was possible to integrate knowledge through drawings or documents. This caused a break in the integration, which in turn caused frustration and time-consuming activities in order to accomplish knowledge integration.

### 5.2.2. Common knowledge

The common knowledge about automation systems facilitated the integration of knowledge. Interaction and communication within the same community relied on the involved actors' *tacit know*ing. Common *routines and rules* were used in the managing of the day-to-day activities. Hence, *perspective making*, by creating and sharing a *common language* and perspective (Boland & Tenkasi, 1995) facilitated the integration.

However, when unique problems needed to be solved there was a need for interaction and communication with actors and structures with complementary and different knowledge domains. This is in line with Kreiner (2002a) who advocates an iterative form where there is need for both similarities *and* differences in the knowledge base. In order to integrate knowledge between practices with different knowledge domains there is a need for *perspective taking* (Boland & Tenkasi, 1995). By integrating knowledge from other knowledge domain the project could explore knowledge and at the same time exploit the *standards and tools* (knowledge) developed in the past.

### 5.2.3. Mediating tools: boundary objects and brokers

*Routines and rules* were the first type of boundary objects. Due to the functional matrix, where the project members were simultaneously part of different functions and projects, it was possible to rely on rules and routines as boundary objects, particularly when was solving "recurrent" problems. These were developed within the different functional units and used in the different projects. The routines and rules, in form of *standards and tools*, were continuously re-developed and integrated in the day-to-day work in the different projects

A second boundary object was the use of *prototypes* or *practical tests*. The practical tests supported the project as a shared arena where the knowledge could be created jointly in order to solve the remaining problems with the hydraulic drives. The prototypes facilitated the interaction between the project and both the intra- and inter-organizational context. By using prototypes it is possible to have a common starting-point from where to start discussing how to resolve the questions that arise (Leonard-Barton, 1994).

A third boundary object was the use of *documentations*. The different texts and inscriptions (Gherardi & Nicolini, 2000) function as mediating tools. During the course of the project, and in the sales phase, documentation was filed and stored according to the required procedures. Instead of reinventing the wheel, the project members could re-use the documentations in

form of drawings and functional specifications when they needed to solve similar tasks. More precisely, the project members translated the solutions into their own context.

Although boundary objects were used in order to integrate knowledge this was not the most prevalent used mediating tool. When knowledge needed to be integrated between the Beta- and Gamma-project the short time-span between the projects facilitated knowledge integration. Adding to the possibility to integrate knowledge between Beta- and Delta-project was also the fact that the same lead engineer was used in the two projects. Individuals were used as brokers when knowledge was integrated. This is in accordance with Ekstedt et al. (1998) who argue that knowledge integration in temporary organizations is mainly based on the individuals as mediators of knowledge. The degree to which two projects overlap seems to affect inter-project knowledge integration—see Prencipe et al. (2005) for a similar view. The formal and informal meetings also formed arenas for knowledge integration, where the individuals could meet and discuss shard interests and problems.

### 5.3. Comparing the two cases

Above we have analyzed knowledge integration in two different work settings: one permanent and one temporary. We hypothesized that we should find knowledge integration differences as well as similarities between the two settings. We found some differences worth discussing.

In the Health care case we can see a clear ambition to standardize the mediating tools, and thereby knowledge integration with formal documents (referrals and laboratory reports) that shall cover the whole integration process. Other boundary objects and brokers are viewed as complements. In the Gamma-case there is also a striving for some formalization, but in this case the formal documents and databases are more seen as the complements while other boundary objects and brokers are the main mediating tools.

Routines and rules are important in both settings. However, we can identify a difference in how these routines and rules affect knowledge integration. In the Health care setting routines and rules were created from the knowledge that was integrated, i.e. within the different groups. In the Gamma-case there was more iteration in the process which resulted in that the routines and rules were created in the project group, i.e. between different functional groups. In other words routines and rules were a kind of boundary objects in the Gamma-case, whereas they in the Health care case were tight connected to different units. It is possible to

think that the Health care could be organized differently, for example, by having laboratory personnel working in the customer settings (in the wards etc.). Such a way to organize the work would probably affect how routines and rules would be developed and used.

In the Health care case the boundaries were quite stable over time. They were treated as semantic, although they in many cases were pragmatic. The latter might be a consequence of the increased specialization in health care. In the Gamma-case the boundary changed over the project's life cycle, starting as pragmatic and moving to semantic and even to syntactic.

It is interesting to discuss the differences, but the similarities we have found can give us more general knowledge of how why is it that boundary activities work or break in knowledge integration.

Although the project concept itself means that there is a *complex* and *unique* task to be accomplished, within a set of requirements and within a certain budget, projects differ from each other. The Gamma-case shows that even if there were complex and unique tasks to be handled there were also quite repetitive tasks. Even if temporary organizations are said to be time-limited, in contrast to permanent organizations that are said to be eternal, the cases shows that it can be the other way around. The Gamma-project showed that many of the standards and tools used were developed a long time ago and they were continuously re-developed to suite the projects. Although the individual showed to be the most prevalent mediating tool the use of standards and tools were quite a common way to integrate knowledge and contributed to make the knowledge less local and less individual. The project management literature also suggests that it, from an intra-project perspective, is difficult to establish relations due to the unique group constellations from project to project (Lindkvist, 2005). However, when looking at the boundary spanning activities taking place we see that many of the intra-organizational relations were established long time ago, and the project team knew who to contact if they had difficulties that needed to be solved.

Lindqvist (2005) argues that project members are more of a knowledge collectivity than a knowledge community. This can be seen in the Gamma-project where the members represent different knowledge disciplines. However, even in the Health care setting we can se the same phenomenon. If we look at the laboratory's routine work, the laboratory technicians are specialized in different analysis areas. One specimen can be analyzed for more than one

purpose involving several specialties—customers, almost always request several analysis for a patient. Then the total process will involve several people and working groups having quite different knowledge bases. This leads to a similarity with the project case in that the required common knowledge for knowledge integration does not exist.

Knowledge in projects is more individual, and not "built into" the organizational memory (Ekstedt et al., 1999; Lundin & Söderlund, 1998). We could find example of how the organizational memory affected the integration in the Gamma-case and we could identify several situations in the Health care setting where the knowledge was clearly individual and not was a part of an organizational memory. A tentative conclusion is that the organizational form is not the most important explanatory factor. The most important explanatory factor seems to be how they (permanent work settings and temporary work settings) organize around activities.

The last similarity we highlight is related to Berggren & Lindkvist's (2001) argument that since the time is limited in project the willingness and possibilities to integrate knowledge are affected. This results in difficulties in establishing deeper relationships in project work. To some extent we could identify this in the Gamma-case, but it was also very clear in the Health care case. Several respondents raised the lack of time and that they could not keep themselves update in all areas. Several of them also explained that they not were interested in microbiology and therefore not motivated to learn more. These respondents did not show special relations to the laboratory. Consequently they use the formal boundary objects in the way they had done before and they seemed to be quite resistant to changes. They work as if the boundaries are semantic and not pragmatic.

## 6. Conclusions and Further Research

We have studied knowledge integration in two different work settings: permanent work setting (a microbiology laboratory) and a temporary work setting (a project). Both the microbiology laboratory and its different customers and the project and its inter-organizational context can be seen as separate knowledge communities. They have to collaborate in the analysis process respective the project process, and from a more overall view they instead form a knowledge collectivity. Lindkvist (2005) primarily discusses from an intra-project level, but the concept of knowledge collectivity could also be used when actors are part of other practices. The use of knowledge collectivity highlights the need to go

beyond the community concept in order to understand boundary spanning activities where the knowledge domains differ and where the actors are not part of "a tightly knit group" (e.g. Brown & Duguid, 2001).

When the practice-based perspective is supplemented with a sort of boundary categorization we can explain some difficulties and challenges that exist in knowledge integration. In both cases, boundaries which are pragmatic are treated as semantic. There is a lack in the knowledge about each others knowledge, and the knowing process between different groups is not sufficient. Boundary activities in form of shared communities, brokers who really have double membership and new ways to handle boundary objects may be parts of the solution.

The case analyses describe and explain boundaries, boundary spanning activities and boundary objects. Given the theoretical lenses, our discussion focuses on what promote or inhibit knowledge integration. A main result of the study is that knowledge integration in the cases was more complicated than the literature suggests.

Both differences and similarities were found between the two cases. Differences were seen in the use of boundary spanning activities and boundary objects. An interesting difference between the cases was the formalization of the boundary objects. In the Health care case there was an ambition to create formalized boundary objects in order to create complete integration tools, while in the project case, the formalized boundary objects were mainly viewed as complements to other integration methods. In the Health care they created routines based on the knowledge they got, whereas in the project organization they adjusted integrated knowledge and iterated more in the knowledge process. This entailed a response, feedback, in the knowledge integration process that often was missing in health care case. The Gamma-case shows that in order to understand knowledge integration we need to understand that the project members are part of *different* communities. Rather than understanding the practice as either a knowledge collectivity or knowledge community the practice was influenced by both community *and* collectivity knowledge, where the boundaries created a need for different ways of integrating knowledge.

Knowledge boundaries between groups with different work tasks are often more pragmatic (i.e. more complex) than group members perceive them to be. Pragmatic boundaries lead to more complicated knowledge integration. The cases suggest that for pragmatic boundaries to

work well it is important to reach a "common understanding" between groups. In the cases, knowledge was integrated from one group to another without reflections on the differences in knowledge bases. The knowledge integration was also in the both cases clearly dependent on "time for reflection" and "interest and motivation". These affect the possibilities to understand each others knowledge and work activities. If group members were not interested or motivated, the boundary objects did not function well.

The analysis of the two cases thus show both differences and similarities, but an emphasis on the latter. A generalization is difficult to make from just two cases and further studies of similarly and different work practices are needed. There are many different work settings and the ways they are organized differ, which in turn could imply that their organizing of activities also differs. For example, the project literature often emphasizes uniqueness as an important criterion for projects, but a project is not completely unique.

Even if we acknowledge the differences in characteristics the question is whether it is fruitful to just look at the organizational form as such and make conclusions about the knowledge integration taking place. If we instead look at the noun *organizing* we look at what actually is happening, despite of the organization form we can draw conclusions about the high degree of similarities between the boundary spanning activities in the two organizational forms. Even in a permanent organization there are unique tasks that affect knowledge integration, especially if processes are treated at a micro level. In the same way, in a temporary organization there are work tasks that are repetitive or in other ways can gain from more formalized knowledge integration.

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