

A GROUNDED THEORY ON KNOWLEDGE SHARING IN INDUSTRIAL RESEARCH: ORINATION MECHANISMS AND THEIR EFFECTS

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ABSTRACT

Organizations need knowledge sharing. However, although many factors influencing the amount of knowledge sharing have been found, the ways in which useful knowledge sharing is initiated and realized is left underexplored. This paper describes ethnographic studies on the realization of the content of knowledge sharing in two industrial research groups. Analyses in line with the grounded theory approach resulted in the concept of 'origination mechanisms'. Origination mechanisms are distinguished on the basis of three dimensions: (1) did the content of knowledge sharing already exist or is it newly developed in interaction? (2) is this selection or development determined by ego, by alter or by management? (3) is this determination oriented at a problem of ego, a problem of alter, a shared problem or no particular problem at all? The paper describes eight frequently occurring origination mechanisms, their preconditions and their contributions to industrial research practices. The concept of origination mechanisms is able to integrate fragmented findings in the literature and uncover existing biases. The paper ends with the knowledge management implications of this new perspective and the empirical findings on knowledge sharing.

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1. INTRODUCTION

A tension exists between the need for knowledge sharing and the abundance of knowledge in many organizations. On the one hand there is a need for knowledge sharing. It has been argued that sharing knowledge prevents reinventing the wheel (Bender and Fish 2000), that it enables the recombination and integration of knowledge (Galunic and Rodan 1998; Grant 1996) and that sharing knowledge enables coordinated action (Hoopes and Postrel 1999). In the context of research and innovation, management researchers have established over and over again that communication contributes to performance (e.g., Pelz and Andrews 1966; Rosenbloom and Wolek 1970; Allen 1977; Tushman 1978; Keller 1994). Therefore many scholars, consultants and managers assume that knowledge sharing in organizations is important and can or should be improved.

On the other hand there is an abundance of knowledge in many organizations. As Hansen and Haas (2001) note, there is a tendency away from information scarcity to information overload in contemporary organizations. In science and research and development this problem has been faced earlier (Garvey and Griffith 1971; de Solla Price 1963). Allen (1977: 7) writes: *“The tremendous increase in recent years in the amount of R&D performed in the world has resulted in a concomitant increase in the amount of information to be communicated”*. The amount of knowledge that can be shared with others is almost infinite. But only a fraction of possible knowledge sharing will be relevant – at least, not all knowledge sharing will be equally effective. The content of knowledge sharing is as important as the amount is. This raises the question how knowledge sharing is realized and, especially, how the content of useful knowledge sharing is realized. This problem has been stated before as a problem of coordinating supply and demand (Hansen and Haas 2001; Davenport and Prusak 1998). In a similar vein, Huber (1991: 107) noted in a review on organizational learning that the way organizational units possessing information and units needing this information find each other quickly and with a high likelihood, is left unexplored. Galunic and Rodan (1998) raised the issue of ‘detection probability’, the chance that opportunities for valuable knowledge sharing are detected.

However, although the problem of the realization of useful knowledge sharing has been acknowledged in the literature, the ways in which organization members deal with it have not been systematically explored yet. A large share of the literature takes the occurrence of knowledge sharing and communication for granted. The majority of studies have only focused on the amount and direction of knowledge sharing (e.g., Allen 1977; Tushman 1978; Hansen 2002; Birkinshaw et al. 2002). The problem cannot be addressed either by referring to the many factors that have been found to influence technical communication and knowledge sharing, such as physical distance (Allen 1977), trust (e.g., Andrews and Delahaye 2000) and organizational crises

(van der Bij 2003). These factors enable and constrain technical communication and knowledge sharing, but do not explain how it is initiated. The lack of attention for the realization of knowledge sharing might be due to the fact that linear communication models have informed most of the earlier studies of technical communication in research and the recent studies of knowledge sharing (e.g., Moenaert and Souder 1990; Szulanski 2000; Gupta and Govindarajan 2000). Linear communication models consider communication to be the flow of a message from a sender, via a channel, to a receiver (Shannon and Weaver 1949; Berlo 1960). In such a model there is no attention for the initiation or realization of the knowledge sharing. Hansen (1999) and Szulanski (1996; 2000) added a phase before actual knowledge sharing, called 'searching' by Hansen and 'initialization' by Szulanski, but neither of them has explored this phase in depth. Moreover, existing interpretations of the problem may contain too many assumptions, narrowing the issue of the realization of useful knowledge sharing to the realization of the transfer of an existing knowledge supply to meet an existing demand.

The study reported in this paper set out to develop grounded theory on possible ways in which organization members can realize knowledge sharing and the preconditions and effects of these different ways. Knowledge sharing has been interpreted broader than the transfer of existing knowledge, including other ways in which organization members can contribute to each others' work in communication as well. Industrial research has been chosen as the empirical domain of study since knowledge sharing has been shown to be important in that context (e.g., Allen 1977). The contributions of this paper are the following. First, it introduces a new concept, 'origination mechanisms', referring to different ways in which the content of knowledge sharing can be realized. This concept is able to integrate existing fragmented insights, to relate different streams in the literature and to identify biases in the existing literature. Second, it describes how different origination mechanisms are instantiated among industrial researchers, what preconditions they require and what effects they are associated with. Third, this paper discusses the knowledge management implications of the identification and characterization of different origination mechanisms.

2. METHODOLOGY

Recent ethnographic studies of knowledge sharing provide an appeal to study knowledge sharing in its natural context (Orr 1990; Cicourel 1990; Lave and Wenger 1991). Work-related communication in laboratories is an integral part of the work of researchers (Lynch 1985). To investigate the ways in which knowledge sharing is realized requires attention for the actual practices of researchers. Further, to understand the process of technical communication requires an interpretative stance, in order to get to learn about their place in the life-world of the group members. Therefore in-depth field studies of knowledge sharing have been undertaken in two industrial research groups. Between April 1999 and December 1999 communication between researchers was studied in the Group Buijs, part of the NatLab, the largest laboratory of Philips Research. Between March 2001 and September 2001 a similar study was done at OGIR, a research group of Shell Global Solutions.

This study can be classified as passive participant observation (Spradley 1980). One of the authors shared rooms with some of the researchers, followed them in meetings and their laboratories, had coffee breaks and lunch with them and joint other social occasions. But he did

not actively participate in their research. In the first phase of the field studies, interviews were held with most of the group members. In the second phase, a number of researchers were followed closely. At the Group Buijs four researchers were shadowed and at OGIR three researchers, for an average of six days. Their interactions during these days were observed and a part of them was tape-recorded. Before and after interactions the shadowed persons were asked to clarify the meaning that these interactions had for them. In many cases we also spoke with their interlocutors afterwards, in order to learn their point of view as well. Some of the tape-recorded interactions were discussed sentence-by-sentence with the researchers, by reading the transcript and / or listening to the tape together. These post-hoc discussions proved to be important to understand what was happening in interactions. The observed interactions comprised accidental meetings at the corridor, lunches and coffee-breaks, interactions between persons occupying the same room, organized meetings, reports, purposeful visits, telephone calls and some emails. Only research-related interactions were analyzed for this paper. In total, more than 250 interactions were observed or documented and labeled with a number (e.g., E26).

Field notes and transcripts of interactions and interviews were analyzed in line with the grounded theory approach (Glaser and Strauss 1967; Glaser 1978). After these qualitative analyses, 102 interactions were coded for quantitative analysis. Many of these remaining interactions were divided into parts, so that every part could be classified exclusively as one type of origination mechanism (see below). This yielded a set of 227 episodes (comprising whole interactions or parts of interactions). From these 227 episodes, 129 stem from the Group Buijs and 98 from OGIR. Preliminary findings were presented to both research groups. These member checks did not necessitate major revisions.

3. DIMENSIONS OF ORIGATION MECHANISMS

This paper has grown out of wonder about how researchers realize knowledge sharing, given that the usefulness of possible messages is far from obvious. The grounded theory analyses have yielded the concept of 'origination mechanisms'. This concept refers to the different ways in which the content of knowledge sharing is realized. In this study, the content of knowledge sharing is identified in terms of 'moves' (see also Berends 2003). A move is something done in communication. A move consists of one or more speech-acts (Searle 1969). Origination mechanisms are distinguished on the basis of three dimensions, which will be discussed below.

DIMENSION 1: EXISTING VERSUS NEW

Consider episode E1, one of the two-weekly group work meetings of the Group Buijs. After the discussion of some organizational issues, Luke¹ is given the floor for a presentation of his research. He starts to tell about a stream of work that he has finished a couple of months ago. Then he tells about the problems he is currently working. He describes some of his first results and explains what plans he has for the future. During his presentation some of the attendants ask questions. These tempt Luke to explain more about his approach and results.

Now consider E37. In this episode the researcher Marc has a problem with the coating process of a certain object. During this process a particular pattern of irregularities is formed. He introduces

¹ Names have been changed in order to protect anonymity.

this problem to Jason, who in turn asks for some details. Based on this, Jason forms a hypothesis on the cause of the problem: water might exist in the coating liquid. He also thinks up a solution for this problem. In this particular conversation, which lasted only for about five minutes, another thing happened too. Marc exclaims at a certain moment: *“I don’t understand it, for it is the same liquid as I am normally using, and then there is no problem. Only now I am using it in black.”* A couple of seconds later he goes on: *“But maybe ... the pattern is there all the time, but you don’t see it. I might be seeing it now because of the dark color”*. Marc comes up with a supplementary explanation for his own problem, explaining the fact that he has not noticed the irregularities before.

We like to draw attention to one major difference between these two episodes. In E1 Luke tells about his own research. What he tells is not new for him. He just expresses his existing knowledge about his own research. In contrast, in E37 both Jason and Marc himself come up with new explanations. Their explanations of the coating irregularities did not exist before this interaction. The origin of their explanations lies in a creative process. The content of the moves is newly developed. Within interactions, participants often actively think about the problems and solutions of themselves and others. This might result in the development of new ideas, which may be communicated within the interaction. This implies that communication does not only consist of telling another what one had already in mind before the interaction. Therefore, the first dimension describing the origination of moves is whether the content of the move already existed before the interaction or not. The distinction between an existing content and a new content can also be stated as the distinction between selecting and developing. The origin of a move was coded as ‘existing’ when the move arises from a selection process either within the interaction or in anticipation upon an interaction. The origin of a move was classified ‘new’ when its content is developed anew in an active cognitive process, such as an act of problem solving, within the interaction or in anticipation upon an interaction.

DIMENSIONS 2: SOURCE OF DETERMINATION

The second dimension of the origination of moves concerns the source directing the selection or development of content. Many selections or developments are possible. Different actors may direct the selection or development. First, this can be ego, the person uttering the particular move. In this research speakers or writers are always identified as ego. Listeners or readers are always referred to as alter. This implies that within an interaction people may alternately be ego and alter. The second person who might determine the content is alter, the person or the person that the speaker is interacting with. This is the case when alter has posed a question to which ego responds. Alter may also be more indirectly directing, by introducing a certain topic. Third, it might be management. This is the case when a manager, group leader or project leader tells someone to tell something to someone else. It can also be that it is not one of the persons directly directing the content, but that the person uttering the move is following a more or less implicit norm. This is the case when it is an acknowledged rule to tell something in a particular situation to someone else. Think for example of many administrative systems and management information systems in place in some organizations. Sometimes it is a matter of degree in which alter, ego or management drives the determination of content. For practical reasons we choose to work with a trichotomous classification.

DIMENSION 3: ORIENTATION

The third dimension is the orientation of the process of origination. This refers to the basis for selecting or developing. It concerns the object that the person who directs the selection or development has in mind. Possibilities are:

- an orientation at a problem of alter
- an orientation at a problem of ego
- an orientation at a shared problem
- no orientation at a particular problem

Take for example the case discussed in the beginning of this section. In this episode both Jason and Marc come up with new explanations for a problem Marc has. The origination of the moves of Jason is new, directed by himself and oriented at a problem of alter, because it is Marc's problem he is thinking about. However, the origination of the Marc's moves is oriented at his own problem. He tells about his problem in order to get a reaction. Later on he develops a new explanation with regard to his own problem. Likewise, selection and development can be oriented toward a shared problem or not be oriented at a particular problem at all.

4. ORIGINATION MECHANISMS, CONDITIONS AND EFFECTS

The three dimensions that have been identified, with respectively two, three and four values, yield 24 logically possible combinations. These are called origination mechanisms. They are (potentially) functionally equivalent ways to initiate and realize technical communication. Out of these 24 logically possible origination mechanisms, 16 were found in the interactions that were analyzed. This section describes the eight most important origination mechanisms, as measured by the frequency of occurrence. The descriptions of the origination mechanisms will pay explicit attention to their conditions and effects as well.

Knowledge sharing can contribute in a variety of ways to industrial research practices. A broad distinction can be made between direct contributions and indirect contributions. Direct contributions are effects that are directly useful for the research problems one is working on. These include a change in the problems one is working on, a contribution to a solution and being activated to undertake a particular course of action or to think about a particular question. Indirect contributions are those effects that are potentially useful in the future. These include a change in background knowledge and a change in knowledge about others. Table 1 shows that origination mechanisms differ in the degree in which they yield direct and indirect contributions. Furthermore, the origination mechanisms require different pre-conditions, which implies that they cannot be employed at will. For example, the necessary conditions for the effective employment of directions by management are seldomly available in research. Management is not often knowledgeable enough to know of information that ego has that might be useful for alter. Therefore, the origination mechanisms that are determined by management do not turn up in the following descriptions.

	number of cases	direct contributions	indirect contributions
existing; determined by ego; not problem-oriented	26	5	23

existing; determined by ego; oriented at problem alter	18	12	8
existing; determined by ego; oriented at problem ego	54	12	38
existing; determined by ego; oriented at shared problem	20	15	4
existing; determined by alter; not problem-oriented	8	0	8
existing; determined by alter; oriented at problem alter	16	13	6
existing; determined by alter; oriented at problem ego	7	0	7
existing; determined by alter; oriented at shared problem	5	3	2
existing; determined by mgt; not problem-oriented	3	1	3
existing; determined by mgt; oriented at problem alter	1	1	0
existing; determined by mgt; oriented at shared problem	1	0	1
new; determined by ego; not problem-oriented	3	0	0
new; determined by ego; oriented at problem alter	37	26	5
new; determined by ego; oriented at problem ego	12	1	5
new; determined by ego; oriented at shared problem	14	12	0
new; determined by alter; oriented at problem ego	2	0	1
total	227	101	111

Table 1: Frequencies of origination mechanisms and their effects

EGO SELECTS, NOT ORIENTED AT A PARTICULAR PROBLEM (DIFFUSING)

The first type of origination that we will discuss is diffusing. That label is used when ego selects existing content without an orientation at a particular problem. What is said is not meant to help anyone immediately. Nevertheless it occurs frequently (26 cases of 227). This origination mechanism, diffusion, takes several forms. One of them is the reporting of finished research, for example by giving presentations, writing reports or publications and by holding a notebook that might later be used by someone else. Both within OGIR and the Group Buijs researchers were used to write reports and give colloquia within and outside their group. Also intranets can be considered as a form of diffusing, when the content of what is put on the intranet is determined by the author and is not oriented at a problem someone has at that moment. Diffusing does not only occur in such more or less formalized settings. Another form of diffusing is telling stories that are just considered nice to tell. An example of this is E206. Two researchers at OGIR have installed a new piece of measuring equipment that is in its specific form unique in the world. To celebrate this joyful occasion they invite all group members for a cup of coffee and a piece of cake. During this meeting one of them shows the apparatus to the group members and tells proudly about its features and about some first results obtained with it.

Diffusing is one way to realize knowledge sharing. However, the observed instances of diffusing seldomly resulted in direct contributions to the work of the researchers.² That does not mean that this type of origination mechanism is useless. It yields frequently indirect contributions to research practices (see Table 1). It often yields a development of background knowledge, further interaction and especially increases in knowledge about others: about the activities of others, but also about their knowledge, their problems. These effects are not immediately useful but may be useful at a later point in time. Knowledge about knowledge of others can be used later to

² The relative frequency of direct contributions stemming from diffusing would be higher when this study would have included the use of internal reports and journals. These can be seen as cases of diffusing as well, but libraries and databases provide more opportunities to select from the offered content.

determine whom one may approach with a certain question. And knowledge about the activities and problems of others makes it possible to think along with them. Chris, a research engineer at the group Buijs, said: *“I do not know what the common opinion is about me. Maybe they occasionally think ‘my goodness, he is only walking around’. Yeah! But if I am just chatting somewhere, that chatting is purposeful: to stay informed about what my colleagues know!”* (NL 990817).

EGO SELECTS, ORIENTED AT HIS OWN PROBLEM (REACTION-DEMANDING)

This origination mechanism occurred most frequently in the interactions studied. In almost a quarter of the coded parts of interactions ego selects what he says with an eye on one or more of his own problems. He says something to get a reaction oriented toward his own problem. Therefore this type of origination is labeled ‘reaction-demanding’. At first sight it seems a remarkable phenomenon that such a large amount of knowledge sharing is not oriented toward others but toward oneself. If we take a closer look this fact becomes understandable. The most obvious form of reaction-demanding is asking questions one has with regard to a problem one is working on. For example, in E72 Robin asks Jason: *“I have to divide parameter I by I_0 . But I_0 is sometimes zero. Can I replace a zero by a one?”*. This origination mechanism also frequently takes the form of reporting about own activities, describing own problems and describing own results. In E209 Malcolm tells in a large lunch-bag meeting about a new type of reaction they recently started working on. He uses no sheets but writes the reaction equations on the spot on a large sheet of paper. He goes on to say that they are looking for ways to improve the pace of the reaction, the process itself and the products of the reaction. Then he asks for suggestions from the audience. In a similar vein reports or concepts of publications are handed over to somebody else to get a reaction. Obviously, this way of initiating the content of knowledge sharing most often yields indirect contributions, predominantly increases of knowledge about others.

ALTER SELECTS, ORIENTED AT A PROBLEM OF HIMSELF (PULLED ORIGINATION)

This origination mechanism often follows the previous one. In the previously discussed origination mechanism someone says something or asks something to get a reaction. By asking something, alter may determine the selection of content by ego. Such an origination mechanism may be called a ‘pulled origination’. The moves that are associated with a pulled origination are describing findings or theory, describing technology, referring to literature and instructing. In E234 Herman tells the heat transfer coefficient of a certain material to Geoffrey, after Geoffrey asked for it. In E167 Mary tells Rick the strength of the relationship between the viscosity and the concentration of a certain liquid. A selection of existing information on the basis of a question oriented at a problem of alter is very effective in yielding desirable answers. In thirteen out of sixteen cases it results in a direct contribution (see Table 1). However, the effectiveness of this mechanism is conditional upon alter’s knowledge of his own needs and his knowledge about who knows what. But alter will not always know what knowledge of others might be useful for him.

EGO SELECTS, ORIENTED AT A PROBLEM OF ALTER (PUSHING)

In the origination mechanism called pushing, ego selects existing content. To that extent pushing resembles diffusing. But contrary to diffusing, the selection process at the heart of pushing is oriented toward one or more of the problems of alter. Pushing involves the belief that alter needs to know something, or that something might be useful for his research activities. Take for example E165. In this episode Pete proposes Richard to show him some different printing techniques that he has studied. Pete knew that Richard had recently started as a research engineer on a project studying a new kind of printing technique. He considered learning something about existing techniques to be useful for Richard. In this case Pete used his background knowledge of printing techniques and his knowledge about Richard's activities to induce that knowing about those techniques would be beneficiary to Richard. After a comparable interaction, Jason said: "*He gave me a solution I did not ask for*". Knowledge sharing may also be useful when there is no pre-existing demand.

Elaborating upon the notion of 'detection probability', discussed by Galunic and Rodan (1998), we introduce the notion of 'detection capabilities': the capability to identify the opportunities for useful knowledge sharing. Pulled originations thrive on the detection capability of the person in need of knowledge. In contrast with pulling, pushing thrives on the detection capability of ego. A prerequisite for pushing is that one has some knowledge of the activities and problems of the other. An advantage of pushing above a pulled origination is that it might present ideas that alter is unfamiliar with or that alter has never thought about. An advantage of pushing above diffusing is that moves are focused at a problem of alter and therefore has a far bigger chance of being directly useful.

EGO SELECTS, ORIENTED AT A SHARED PROBLEM

Researchers frequently work together in projects. In virtually all projects there is a division of labor, which gives each of the project members his own sub-problems. But in projects there are also overarching questions that can be considered problems shared by the project members. Another type of shared problem is the meta-problem of developing new research problems, new areas of research. At the Group Buijs and OGIR this could be seen as a joint responsibility of the group leaders and the researchers of a certain cluster. Knowledge sharing can also be realized by a selection by ego oriented toward such a shared problem. This origination mechanism is characterized by moves like suggesting a technical solution, describing findings and theory, describing own results, describing technology, hypothesizing, giving arguments and instructing. For example, in E86 the research scientist Pete gives his assistant Rick samples of liquids and asks him to determine their rheological properties. The selection of content by ego oriented toward a shared problem leads often to direct contributions to research work and less to indirect contributions. These direct contributions consist typically in a change in the researchers' problem-portfolio or new actions by one or both of them, such as new communicative actions, an intensification of thought on a particular subject and the execution of experiments.

DEVELOPMENT OF NEW CONTENT BY EGO, ORIENTED AT A PROBLEM OF ALTER (THINKING ALONG)

The previously discussed origination mechanisms are characterized by a selection of existing information. What is said already existed. When communication is associated with concepts like information transfer, information exchange, knowledge transfer and knowledge flows it seems

that everything that is communicated was already existing somewhere before it was uttered to someone else. That is not true. In 66 out of the 227 cases something was said that was more or less new to ego himself. That is, it was developed, consciously or unconsciously, during the interaction or in anticipation of it. In (E26) Richard went to Henry to ask for a heating element to use in measuring equipment. Henry rejects that option, but comes up with the idea to use ice to cool instead. Richard puts this idea into practice. He says: *"I went for something completely different. But they are so clever. I will ask him questions again."* In 37 of these cases this new content was determined by ego, oriented toward a problem of alter (like in this one). This type of interaction might be called thinking along with somebody. Thinking along consists of temporarily applying one's knowledge to another one's problem. It both requires relevant technical background knowledge and knowledge about the problem of alter. Due to the specific nature of working in a research environment, thinking along has an irreplaceable value. Researchers are set to work on problems for which it is assumed that no solution exists already. Otherwise, research would not be necessary. This implies that others cannot give such a solution when asked for. In that case they may help by thinking along. Moves stemming from this type of origination mechanism are suggesting a technical solution, hypothesizing, suggesting an experiment, giving arguments, asking questions, questioning, agreeing, rejecting, concluding and summarizing. Thinking along with somebody is not restricted to single face-to-face meetings. Evaluating a report by somebody also classifies as thinking along, as long as some new ideas or opinions have been formed with regard to the report that are communicated later on. Thinking along often leads to direct contributions. This may consist also in a change in one's degree of belief in a solution. For example, in E69 Luke shows Jason a graph of the characteristics of a filter he uses in a camera and asks whether he considers this filter good enough. Jason answers confirming. Because Luke considers Jason to be a near-expert in optical matters, this agreement is for Luke the reason to increase his belief in the reliability of the filter.

DEVELOPMENT OF NEW CONTENT, ORIENTED AT ONE'S OWN PROBLEM (SELF-SUGGESTION)

Like one can think about somebody else's problem, one can also think about one's own problem in interaction. The need to explain one's own problem or the need to defend one's ideas stimulates to come up with new explanations, solutions, arguments and conclusions. Some researchers remarked that they purposefully talked to others, not to get a useful reaction, but to force themselves to structure their thoughts. One example of self-suggestion was described in the discussion of the dimension existing versus new. In that interaction, E37, Marc comes up with an alternative explanation for the coating problem he has. Another example can be found in E53. When Robin is in the office of Jason, Jason asks the question whether it would be possible to show the working of a derotator on an overhead projector. It requires that a rotating and a fixed picture can be seen simultaneously. Jason himself starts drawing at a whiteboard and soon after finds that there is a simple way to do it. *"Brilliant"*, he exclaims, *"that is something to show at the conference. I have to ask Gerald about that"*. Self-suggestion is a borderline-case with respect to our initial problem, how knowledge sharing is realized. What is communicated in self-suggestion is not useful for the other, but for oneself. However, it is the presence of somebody else and the inspiration drawn from the remarks of others that probe new ideas.

DEVELOPMENT OF NEW CONTENT, ORIENTED AT A SHARED PROBLEM (COLLABORATIVE PROBLEM SOLVING)

This origination mechanism can be seen as a mixture of the two previous types. An orientation at a shared problem is both an orientation at one's own problem and an orientation at a problem of alter. It may be labeled collaborative problem solving. Moves that are particularly associated with this type of origination mechanism are suggesting a technical solution, suggesting research activities, suggesting experiments, on the spot calculating / trying, expressing observations, asking questions, giving arguments and expressing observations. These moves evoke the image of two persons working together at the laboratory bench. An example of this can be found in E56. Three days before this interaction Jason and Rick have thought up a series of spin-coating experiments that they would like to carry out in a clean room. In E56 they are executing these experiments, together with two technicians. They inspect coated discs by the bare eye and under a microscope. They tell each other what they see. They perform scratch-tests and look at the resulting scratches under a very strong microscope, again telling what they observe. Collaborative problem solving often changes problem-portfolios and often yields contributions to a solution. It is evident that new solutions are developed during collaborative problem solving. Those results often lead to new questions as well. Each of the twelve instances of this origination mechanism led to a direct contribution.

5. DISCUSSION AND IMPLICATIONS

The knowledge of one organization member is often valuable to others as well. However, one cannot assume that useful knowledge sharing occurs automatically. This paper introduces the empirically grounded concept of origination mechanisms to capture the possible ways to realize knowledge sharing. No equivalent concept can be found in the literature. The way knowledge sharing comes about is often taken for granted. Only some fragmented insights can be found. For example, several authors make the distinction between pushing and pulling (e.g., Rosenbloom and Wolek 1970: 39; Langrish et al. 1972: 73; Holsthous 1998; Schulz 2001: 664). This distinction correlates with the distinction between a determination by ego and a determination by alter. Further, at some scattered places in the literature the distinction between new and existing content has been mentioned (e.g., Baker et al. 1967). The different 'modes of obtaining information' that were distinguished by Myers and Marquis (1969: 83) correspond partially to some origination mechanisms, but their overview is far from complete, nor systematic. The concept of origination mechanisms is able to integrate these fragmented insights.

Furthermore, the integrated concept of origination enables us to identify fallacious assumptions and biases within existing literatures. To start with, much of the literature seems to assume that information or knowledge that is transferred already existed before the interaction. This holds, for example, for transactive memory studies (e.g., Wegner 1987) and the information seeking literature (Leckie et al. 1996; Anderson et al. 2001). The assumption that information is already existing waiting to be transferred seems to underlie concepts like flowing, collecting and distributing, the idea of sources out of which knowledge or information can be derived and that knowledge management should prevent 'reinventing the wheel'. Another bias in the existing literature is that, although the distinction between pushing and pulling has been made frequently, many studies only focus on 'pulling'. This is for example clear in the 'search and transfer model' of Hansen (1999) and the conceptualization of knowledge sharing by Szulanski (1996; 2000).

According to Schulz (2001), the information processing approach (Galbraith 1973; Tushman and Nadler 1978) is wholly based upon the 'pull' assumption. Again, this bias is particularly present in literature on the information search behavior of scientists and engineers (Leckie et al. 1996; Anderson et al. 2001) and transactive memory studies (e.g., Wegner 1987). But information is not only looked for. Information can also be brought to someone – even when there is no demand. Table 1 even indicates that most direct contributions are not realized via the retrieval of existing information.

In addition to the identification of biases in the literature, the concept of origination mechanisms enables the localization of different streams of research within the space of possible origination mechanisms. Studies of collaborative problem solving and brainstorming typically focus on the development of new content, oriented toward a shared problem (e.g., Paulus and Yang 2000; Okada and Simon 1997). The construction of databases and intranets concerns the origination mechanism labeled 'diffusing' (e.g., Hansen and Haas 2001). Studies of information retrieval focus on pulled originations and diffusing. Studies of the so-called 'self-explanation effect' concern the mechanism labeled 'self-suggesting' (Dillenbourg et al. 1996). These different studies have focused on particular origination mechanisms, without recognizing them as one among many other origination mechanisms.

Finally, the results of this study may inform the diagnosis of knowledge sharing problems and the development and evaluation of knowledge management instruments. Particular knowledge management initiatives are likely to support only one or a few origination mechanisms. The codification-strategy in knowledge management promotes the collection, storage and retrieval of knowledge. However, such a strategy, instantiated in databases and intranets, supports only the origination mechanism labeled 'diffusing'. Since each of these mechanisms has specific strengths and conditions, it is wise not to bet on only one mechanism. Moreover, the origination mechanisms that are most likely to yield direct contributions are those that are oriented at a problem of alter or a shared problem. For example, the effective facilitation of knowledge sharing also stimulates the detection capabilities of others. Furthermore, the facilitation of knowledge sharing should not only focus on the transfer of existing information, but on the creation of content in interaction as well. The creation of new content in interactions has an irreplaceable value, since not all content does exist already, especially in research. The creation of new content can even be realized through self-suggestion, in which ego thinks up new ideas while thinking on his own problem, possibly inspired by alter. Finally, communication that yields indirect contributions should be supported as well. Knowledge that is not directly useful now may turn out to be so at a later moment in time (Garud and Nayyar 1994) and communication that yields knowledge about the problems and knowledge of others enables later direct contributions.

Needless to say, concepts and findings should be tested and elaborated in further research. For example, it should be verified whether the same origination mechanisms can be found in other organizational functions, such as development, manufacturing and marketing. Furthermore, it is an open question whether the associated contributions of these origination mechanisms are the same in other functions. For example, we hypothesize that in more formalized and centralized organizations, such as insurance companies and production departments, the amount of management directed originations will be more effective and more frequent.

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