HEEDFUL INTERRELATING AS A CULTURAL COORDINATION MECHANISM FOR FLEXIBLE KNOWLEDGE INTEGRATION

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ABSTRACT

In this paper we discuss the results of a study into the emergence of a regular pattern of knowledge integration in two research groups. The study shows how a regular pattern of knowledge integration emerges through a practice of heedful interrelating in the design, execution and ending of projects. We found that heedful interrelating was responsible for an effective, efficient and flexible pattern of knowledge integration. Heedful interrelating specifies local circumstances and thereby provides additional insights to the general mechanisms of rules, directives and routines which cannot explain effective, efficient and flexible patterns of knowledge integration on their own. The emergence of heedful interrelating appeared to be an ongoing accomplishment. The mixed presence of heedful and heedless interrelating appeared to be related to the effectiveness and efficiency of the performance of the group.

Key words: knowledge integration, heedful interrelating, research groups

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1. INTRODUCTION

The objective of this paper is to discuss the results of a study into the emergence of a regular pattern of knowledge integration in two research groups. It addresses behaviors in these groups related to knowledge integration and links these behaviors to performance. This paper in particular addresses how a regular pattern of flexible knowledge integration can emerge through heedful interrelating. Heedful interrelating is defined by qualities as "noticing, taking care, attending, applying one's mind, concentrating, putting one's hart into something, thinking what one is doing, alertness, interest, intentness, studying and trying" (Weick & Roberts, 1993, p. 335). Knowledge integration is considered to be the most essential process taking place in organizations (e.g. Grant, 1996; Ethiraj et al., 2005; Nickerson & Zenger, 2004). Particularly as the delivering of innovative products and services by professional organizations requires effective, efficient and flexible integration of knowledge (Grant, 1996). Routines and directives are able to integrate a broad range of knowledge efficiently (Grant, 1996). Flexibility of knowledge integration has been associated with organic structures (Eisenhardt & Martin, 2000). However, such descriptions do not yet explain how a regular pattern of knowledge integration emerges in a research group. Furthermore, literature focuses strongly on NPD projects, exploring the relation between the kind of knowledge brought into the process of knowledge integration and the knowledge integration mechanisms applied (Enberg et al., 2006; Turner & Makhija, 2006; Becker & Zirpoli, 2003), exploring the relation between mechanisms for knowledge integration in NPD projects and the resulting product innovation (Leiponen, 2006; Hislop 2003; Cummings & Kiesler, 2005; Sicotte & Langley, 2000) and exploring project design and the type of knowledge exchange, learning and performance (Chen, 2005; Hoegl & Weinkauf, 2005).

Empirical literature explaining regular patterns of knowledge integration related to performance is scarce. Both empirical studies (i.e. Faraj & Sproull, 2000; Bresnen et al., 2003; Verona & Ravasi, 2003; Hoegl, Weinkauf & Gemuenden, 2004; Zárraga & Bonache, 2005;) and (more) conceptual studies that do have addressed regular patterns of knowledge integration have produced rather generic interpretations (Eisenhardt and Martin, 2000; Ditillo, 2004; Lang 2004) and do not provide insights how exactly an effective, efficient and flexible regular pattern of knowledge integration emerges and continues to emerge. Therefore, the objective of this paper is to provide more insight in patterns in the regular, everyday practices that members of professional organizations use to integrate knowledge and to relate these practices to performance.

We studied the pattern of knowledge integration and related behaviors within two research groups, using a combination of retrospective and field study methods. These research groups are engaged in competition, serve clients that ask for products that require knowledge integration, within a restricted budget and time-span.
 The contributions of this paper are as follows. First, we present a regular practice of knowledge integration exhibiting a pattern of heedful interrelating. The practice of heedful interrelating results in an effective, efficient and flexible pattern of knowledge integration. Second, these findings explain why routines and directives by themselves are insufficient for knowledge integration, by showing the implications of the behavior of the researchers involved in knowledge integration. Third, the findings deepen and expand the concept of heedful interrelating.
 This paper proceeds as follows. In the next section we review literature on knowledge integration. Subsequently we describe the case study sites and the research methods that were used for data collection and analysis, after which we present our

findings. We discuss the implications of our findings, discuss limitations, and finally summarize our conclusions.

2. THEORETICAL BACKGROUND

Knowledge integration can be accomplished by different coordination mechanisms: rules and directives, sequencing, routines and group problem solving & decision making (Grant, 1996). Grant argues that three characteristics of knowledge integration have to be met to create and sustain a competitive advantage based on knowledge integration: scope, efficiency and flexibility. He defines the scope of integration as the breadth of specialized knowledge the organizational capability draws upon, efficiency as the extent to which the capability accesses and utilizes the specialist knowledge held by individual organization members and the flexibility as the extent to which a capability can access additional knowledge and reconfigure existing knowledge (p. 380). Recent studies illustrate that different knowledge mechanisms result in different products (Turner & Makhija, 2006; Becker & Zirpoli, 2003; Leiponen, 2006; Hislop 2003; Cummings & Kiesler, 2005; Sicotte & Langley, 2000) and thereby that not all mechanisms are equally effective, efficient and flexible. These studies suggest that knowledge integration is local, dependent upon social conditions and the context in which it has to take place. The localness of knowledge integration is also suggested by recent studies that explore the social conditions enhancing knowledge integration (Ditillo, 2004; Lang, 2004; Chen, 2005; Akgun et al., 2006).
  However, the knowledge integration mechanisms identified by Grant (1996) are still defined in general terms, lacking an expression of embeddedness in local practices. Directives are defined as "impersonal approaches to coordination" that "involve … standardized information and communication systems" (Grant, 1996). Rules are defined as "standards which regulate the interactions between individuals" (Grant, 1996) and organizational routines are defined as "repetitive, recognizable patterns of interdependent actions, carried out by multiple actors" (Feldman & Pentland, 2003). Knowledge integration based on these mechanisms suggests that repeatability is a core characteristic. However, the repetitive nature of these mechanisms does not necessarily imply that patterns of knowledge integration are exactly replicated over time. Recent work in organization studies suggests that organizational processes have an open-ended character (Tsouskas and Chia, 2002). At any point in time, what is going on in a social system is not fixed but inherently indeterminate (Tsoukas, 1996). Human agents select out on the one hand what they understand to be the relevant aspects of both their role and their personal norms and values, and on the other those relevant aspects of the local conditions within which their actions take place, and they try to fit the two together. This process of achieving fit is therefore local. The actual local performance of routines may require or lead to their adaptation (Feldman & Pentland, 2003). Small adaptations to changing circumstances can be shared and institutionalized and can become a modified behavioral vocabulary. Empirical work on routines has showed how routines are both a source of stability and a source of change (Feldman, 2000; Feldman and Pentland, 2003; Pentland and Reuter, 2004). This conceptualization of routines as essentially open-ended makes it possible for other processes to invade or contribute to the operation of these routines. This open-ended character also holds for directives and rules, particularly as their definitions are 'impersonal' and need translation to the particular situation in time in which they are applied. Heedful interrelating could be a mechanism which translates these three general knowledge integration mechanisms towards particular local practices.

In this paper we will argue that a pattern of heedful interrelating as a cultural coordination mechanism is responsible for a highly effective, efficient and flexible way of knowledge integration. Heedful interrelating is defined in literature as an attitude, affecting the process of interrelating between people. It exists potentially as a kind of capacity in an ongoing activity stream and emerges in the style with which activities are interrelated. Groups or organizations in which heedful interrelating emerges, will experience variations in heedful interrelating according to Weick & Roberts (1993). Heedful interrelating therefore, is not a static property, but has to be accomplished over and over again. This focuses attention towards the situatedness of action (Suchman, 1989) and improvising qualities of heedful interrelating. As heedful interrelating can be interpreted as how (repetitive) actions or activities can be conducted, variations in heedful interrelating also draw attention to variation in the execution of organizational routines. This makes the anchoring of heedful interrelating relevant. As a group achievement, it is assumed to be anchored in shared meanings, shared (social) rules and individual motives (Weick & Roberts, 1993; Druskat and Pescosolido, 2002; Dougherty and Takacs, 2004). However, literature does not provide explanations how exactly heedful interrelating is anchored. With regard to its continued emergence, Weick and Roberts (1993) argue that heedful interrelating is not necessarily related to group development, although they suggest that groups may be smartest in their early stages. This may be due to activities that contribute to heedful interrelating in the early start-up stages of a group, arising from the need to orient oneself within the team, clarify facts, and test assumptions (McChesney and Gallagher, 2004). Consequently, the level of heedful interrelating may be highest in early stages of a group's existence and may become less when interrelating becomes more routine. Heedful interrelating is not only assumed to exist in particular in young groups, it is also related to highly codified, heavily routinized and well-practiced settings (Becker, 2005), with clear role structures (Bechky, 2006), high task interdependency, low autonomy, and as operating within a system that is concrete and has clear boundaries (Hutchins, 1991; Weick & Roberts, 1993; Hutchins and Klausen, 1996; Faraj and Sproull, 2000).

Literature suggests with regard to the relation between heedful interrelating and group effectiveness that the more heedful interrelating the better, especially to prevent errors and to comprehend unexpected events that evolve rapidly (Weick & Roberts, 1993; Druskat & Pescosolido, 2002; Dougherty and Takacs, 2004; McChesney and Gallagher, 2004). What remains underexposed is what heedful interrelating implies for knowledge intensive organizations or groups that are part of such a type of organization. Therefore this paper seeks to uncover heedful interrelating as a cultural coordination mechanism for knowledge integration, translating the general knowledge integration mechanisms of rules, directives and routines towards particular local practices.

3.   RESEARCH METHODS

We studied knowledge integration practices in two groups. Both groups were part of a research organization working in the domains of agriculture, nature, fisheries, food quality and safety, environmental management, and their social-economic context. We will refer to this organization as the research organization for "Food & Environment". It consists of several institutes, each focusing on a specific domain. The first field study took place in the Ecology Group (group size 51 members), the second in the Postharvest Group (group size 31 members). Although both groups are part of Food & Environment, they work in different research domains and are part of different institutes. The Ecology Group works in the field of landscape ecology and the Postharvest Group works in the field of post harvest physiology. Both groups conduct

research in a multidisciplinary area. Their research is directed towards the development of new concepts, methods and approaches, but is focused on providing science based solutions for problems posed by clients in particular. Both groups have developed a specific strategic position, focusing on innovative, complex problems, which require the flexible integration of distinct capabilities.

The groups operate in an environment characterized by a moderate level of dynamics. In the period that was taken into account for this study (1983-2001), "Food & Environment" experienced some major changes. "Food & Environment" changed from a directorate of the Ministry of Agriculture into an independent organization. This means that "Food & Environment became responsible for its own continuity and had to acquire research contracts. These include projects for the Ministry of Agriculture as well as for other clients. In the period between 1991 and 1998 all research groups (including the groups in this study) were directed to develop a market and client oriented approach, to work according to business economic rules, to develop marketing skills, and to develop a stricter system of research management.

This study combined real time field work with retrospective analysis. We chose to study a period of about 18 years (1983-2001), based on the development of the theme of landscape ecology in the Ecology Group at the beginning of the 1980s. We also started the analysis of the Postharvest Group from the beginning of the 1980s as from this period on the field of post harvest physiology also experienced important changes.

Data collection was led by the principle of triangulation (Jick 1979). We used three kinds of techniques to collect data: observations, interviews, and documents. One of the researchers participated in 2001 in the Ecology Group for 17 weeks and in the Postharvest Group for 30 weeks (with an interruption of eight weeks). During this period, he participated in the groups in a passive way. He did not participate in the work (activities) of the group, but he was in the place where the group works and participated in coffee breaks, lunch and group meetings. In this period he walked the hall ways regularly to observe interactions between the group members. In the Ecology Group he also observed generic e-mail traffic between group members and other colleagues in the group.

Besides informal conversations with group members, a range of more formal interviews were held. We interviewed ten group members in the Ecology Group and eight group members in the Postharvest Group. Before the interview we sent the interviewees a short introduction of the study. The interviews were semi-structured (Kvale, 1996). A predefined list of themes was discussed in the interview, but interviewees were also provided with the opportunity to introduce topics during the interview. Each interview took between one and a half and two and a half hours. All interviews were tape recorded and transcribed. At the end of each field study the preliminary results were discussed with the group leader and presented to the whole group. These member checks (Swanborn, 1996) yielded additional data and led to the refinement of results.

We also studied a large number of documents, referring to the past of the groups as well as to the present situation and near future of the groups. These documents included strategic plans, all annual reports between 1983 – 2001, project descriptions (about 120), descriptions of research programs (about 25), introduction programs for new group members, policy documents, government policy documents describing developments in the environment of the groups and various other documents.

Data were analysed in accordance with the procedures of the grounded theory approach (Glaser and Strauss, 1967). Grounded theory is advocated for process studies that are oriented at conceptualization and theory construction (Langley, 1999). We used the software package Atlas.ti to enhance the traceability of our data analysis (Yin 2003).

4. FINDINGS

4.1 The focus of research work

The Ecology Group works in the field of landscape ecology. Its research focuses on the survival, sustainable development and extinction of populations of plants and animals (amphibians, insects, birds, and mammals), while taking into account the qualities of the landscape and habitat in which these species live. Central concepts in this group are the cutting up of areas in which species live and the connection of ecological niches to enable transfer between niches and thereby the survival of species. The researchers of the Ecology Group were jointly able to develop spatial images of sustainable nature, tailored to the ever changing needs of clients. The images, at several spatial scales, are developed to highlight and solve problems, to predict effects and future developments, and to evaluate policies. This capability was the basic reason for clients to prefer this group over competitors.

The Postharvest Group, works in the field of post harvest physiology. This field focuses on research into the preservation of the quality of fresh harvested products. It not only takes into account the physiological qualities and physiological processes in the product, but also their interaction with the environment and the opportunities to affect environmental conditions (which in turn can affect physiological processes in the product). The group concentrates on fruits, vegetables, ornamentals, potted plants and potatoes. Key words that describe their work are storage techniques, physiological processes, development of molecular markers and new packaging concepts. Clients choose for the Postharvest Group because of their ability to provide practical solutions in the field of post harvest physiology, based on scientific knowledge of physiological processes in fresh products, environmental factors and the decline of quality in the post harvest phase of the chain.

4.2 The structure of research work and the guidance of knowledge integration

Research work in both groups was organized into projects. The groups did not work on one project at a certain moment in time, but on approximately 60 projects. Some of these projects were small and took only a number of months; other projects were large and took a number of years. Therefore the groups worked on projects in different phases at one moment in time.

Three project phases described the project life cycle: designing a project proposal, executing the project and ending the project. Within the three phases of the project life cycle, seven activities organized the interaction between the researchers in the groups and between researchers and clients. As each project had innovative features and had to meet specific requirements of the client, it was important to make these requirements as clear as possible (1: specifying the request of the client in interaction with the client), including the required expertise to answer the research problem (2: translating the request of the client into the expertise needed). Next, the project leader searched for and committed colleagues with the expertise needed (3) and started the project. Near the end of the project results were transferred to the client (4) and – if necessary – post project work was executed (5). Central in the execution of project, however, was knowledge integration (6). Finally, project management (7) guided interaction. Knowledge integration addressed all kind of activities in which individual knowledge of the researchers (in- and outside the project) was integrated to realize the desired project result. Some of these activities were planned, others occurred spontaneously and *ad hoc*. Kim and Peter (both Ecology Group) supplied two examples of planned knowledge integration activities. Kim explained how to organize a project, stating: "We have

content related project meetings, in which the whole project team or researchers involved in a certain aspect of the project meet. A project leader is supposed to organize regular meetings in which concepts and results are discussed. Project members are all informed, even if they can not attend a meeting". Peter refers to team meetings (a team being a subgroup within the Ecology Group): "Team meetings are structured by domestic affairs and research related affairs. In the research related part of team meetings we discuss projects the team is working on. You tell about the state of affairs and problems you experience and the other team members make suggestions related to your presentation". Larry (Postharvest Group) mentions two more spontaneously and *ad hoc* forms of knowledge integration: "I often contact colleagues who worked with that crop and ask them for suggestions. In team meetings, but also when we are drinking coffee or when we having lunch" and "Laura is my room mate. I have a lot of discussions with her about experimental designs, results and scientific theories".

Compared to competitors, both groups focused more strongly on innovative projects that required the integration of a broad knowledge base. In project work, distinctive competences in the research domain and competences in the social domain joined. Both groups were found to have a broad knowledge base at their disposal (table 1). In 2001, 95% of the projects in the Ecology Group was staffed by two or more researchers. In the Postharvest Group this was the situation in at least 82% of the projects. An analysis of cooperation between researchers in projects (2001) and publications (2001-2003) showed that researchers did not collaborate with the same colleagues over and over again, but collaborated in ever changing combinations.

Table 1: Examples of distinctive capabilities applied in a wide range of application areas

Ecology Group

Examples of capabilities
- Development of models that describe accumulated knowledge about the survival of meta-populations of valuable species (plants & animals) in a particular ecological system
- Application of these models for a wide range of problems to predict effects of measures for a wide range of valuable species and for various spatial levels
- Development of norms and conditions for the habitat of a species in order to survive
- Development of guidelines through which knowledge of meta-populations of valuable species related to characteristics of a habitat can be translated for application in local landscape planning processes
- Development and application of process descriptions of fragmentation and de-fragmentation of landscapes related to measures in environmental management (in nature areas and culture landscapes)
- Development and application of knowledge of indicator species, that stand for the survival and wellbeing of a collection of species (of valuable plants or animals)

Postharvest Group

Examples of capabilities
- Development of knowledge of biological processes that take place in fresh harvested products related to the environmental conditions (as for instance temperature, light, air composition, the presence of other products) under which they are stored and transported
- Development and application of methods to prevent or solve problems in the decline of quality of fresh harvested agricultural products in the chain from grower to consumer (cut flowers, potted plants, bulbs, vegetables)
- Development and application of methods to prevent or solve problems in the decline of quality of potatoes and fruits (particularly apples and pears) during storage
- Development of measurement methods to measure the current quality of fresh harvested products and to predict the decline of quality during the remaining post harvest period of this product

This implies that there is flexibility and scope in the knowledge integration practice of the groups. For example, the prediction of the effects of the location of nature areas and connecting corridors on the migration and hence survival of the deer for one of the Ministries in the Netherlands included a number of the same capabilities as solving the location problem of a nature bridge over a highway in the province of Utrecht (granted by a community in this province) to connect two nature areas. Yet this second project also required expertise about the local circumstances, the effect on several other species apart from the deer, expertise about governance issues and expertise of the effect of the habitat of this bridge on migration patterns.

Twelve social rules guided interaction in projects. Of these rules, four guided interaction with clients, the other eight guided interaction between researchers. The four rules guiding interaction with clients prescribed "to provide a satisfied client", "to respect the client", "to involve the client in making a project proposal" and provide freedom to the project leader with regard to project evaluations as he "does not have to involve the client in an evaluation". With regard to knowledge integration the effect of these rules is that they enhance the effectiveness of knowledge integration as they stimulate researchers to listen carefully what the client desires: before the start of a project, during its execution and at the ending of a project. Not involving the client in an evaluation seems to be in contrast with the other three rules, but it only addresses the absence of a formal policy of external evaluation of projects. The rules prescribing to provide a satisfied client and to respect the client appeared to be sufficient to reflect with the client during the start-up, the execution and ending of a project.

Of the eight rules guiding interaction between researchers, four stimulated researchers to actively search for, involve and value the expertise of colleagues: "involve the colleagues you need in your project", "be open and behave like a good colleague", "a success is always a shared success" and "the project leader involves his project team". The rule be open and behave like a good colleague prescribes to take up an open position, referring to behaviors as providing advice, thinking along, discussing project design, project execution and results. Kim for instance, stated in this respect: "Whether or not you're doing your job the right way appears from the reactions of your colleagues. Are you involved in problem solving, do colleagues consult you, do they involve you in their project? If this happens, you're doing your job properly". The other four rules all have a somewhat different orientation. The first suggests (requested) project members to refuse an invitation for participation if they face a lack of time or in order to anticipate tensions in the project team ("if you don't want to participate in a project, you don't have to"). The second and third are related to the ending of projects, prescribing that "ending a project is primarily the task of the project leader" and "the evaluation of a project is obligatory, but you don't have to follow that rule". The fourth rule prescribes the project leader to manage the project in a way that keeps the gap between the project budget and the project spending small and to realize this aim in perspective of the continuing need for interactions between researchers of the group ("work decently and as a good colleague"). Although the effect of these last for rules could be that they constrain knowledge integration, they did not. The task not to exceed the project budget limits the time spent on discussion between researchers and thereby limiting the amount of knowledge integration by face to face interactions. However, as the rule also prescribed to realize this aim in perspective of the continuing need for interactions between researchers of the group, its constraining effect was undone. Ending a project by the project leader did not constrain knowledge integration, as the project leader still could ask colleagues for help. When project members had provided their contribution they faded out at the end of a project, contributing to a new project

and thereby helping to keep the project within budget as every hour had to be accounted for. As researchers were of the opinion that the scientific results and the research process were discussed enough during the execution of the project in all kinds of meetings, that recommendations – if any – were embodied in the group and as financial margins were small, evaluations take time and reduce the financial result they did not formally evaluate projects. But as they informally did, knowledge integration with respect to what was learned and could be applied in future projects was not harmed. Finally the possibility to refuse an invitation to participate in a project could harm knowledge integration as a project leader could miss a researcher in his project team with a very specific kind of expertise. However, this rule did not provide a lot of trouble in daily working practice. Reasons other than that a colleague had no time available were not frequently encountered. In situations like these, project leaders tried to make creative arrangements to make the expertise of this researcher available, for instance to involve the researcher as a reviewer. These kinds of arrangements reduced the demanded time considerably.

The social rules were not particularly related to one of the seven activities in the project life cycle, but they guided the execution of two or more activities. As the seven activities cover the whole project life cycle, the pattern coming forward from the social rules is not specific for one or a few activities or for one of the phases in the project life cycle, but for the whole project life cycle.

4.3   Heedful interrelating as the dominant pattern to interrelate in projects
The social rules suggest that researchers take their work very seriously and interact heedfully, with clients, as well as with colleagues. Because the qualities of heedful interrelating are present in the identified activities in the whole project life cycle the findings suggest that the dominant pattern in the practices of the groups with regard to the project life cycle is a pattern of heedful interrelating.

The social rules suggest that the researcher thinks along (rules "involve the client in making a project proposal", "involve the colleagues you need", and "be open and behave like a good colleague"), is open for advice (rules "involve the colleagues you need", "be open and behave like a good colleague"), applies the expertise of others (rules "involve the client in making a project proposal", "involve the colleagues you need", and "be open and behave like a good colleague"), involves colleagues and clients (rules "involve the client in making a project proposal" and "the project leader involves his project team"), values the contributions of others in a project (rules "the project leader involves his project team", "a success is always a shared success") and embodies recommendations learned from previous projects, although not through a formal evaluation (rule "the evaluation of a project is obligatory, but you don't have to follow that rule"). These are all examples of heedful, attentive behavior.

Heedful behaviors had a number of effects related to knowledge integration in terms of effectiveness, efficiency and flexibility. Related to clients these heedful behaviors enhanced effectiveness of knowledge integration as the demands of the client were leading in the design of the project, its execution and ending. Researchers listened carefully to and interactively translated the demands of the client into a project proposal and were stimulated to actively search for, involve and value the expertise of colleagues needed to provide a result fitting the demands of the client. As Andrew (Ecology Group) stated: "you do want to satisfy the client, that aspect of the work receives a lot of attention". These heedful behaviors also enhanced efficiency. First of all as these

behaviors enhanced effectiveness, they reduced the amount of additional, post project work that had to be done in order to satisfy the client. As the research groups competed for project grants in the market, efficiency was quite important. Joe (Ecology Group) for instance stated in this respect: "As researchers have to be financially covered, we do not want to be too expensive related to competitors. Therefore margins are relatively small to provide a positive financial result at the end of a project. In addition researchers often really want to acquire a projects [in order to work on what they like and to be financially covered], and make margins in the project budget even smaller which leads to problems even before the project has started." Heedful behaviors also raised efficiency as they enhanced the approachability of researchers, thereby easening the execution of the project life cycle and raising the possibilities to include valuable knowledge and suggestions within constraints of time and budget. Finally these behaviors stimulated flexibility as they stimulated the inclusion of the most valuable expertise in the group needed to solve the problem of the client. As these behaviors did so for each project, it provided a way of making very flexible combinations of expertise.

Heedful behaviors were embedded in the motives of researchers, based on a well understood self-interest. For researchers the most important thing was to work on what they like (a motive). Working on what you like has to do with the content of the work, the research topics you like to work on. Researchers put their heart into research work, specializing in a specific subject or aspect of the field of research: "Researchers just want to do the kind of research they like. They want to develop a scientific profile, therefore you must develop a professional status in a field of research" (Andrew, Ecology Group). For a researcher to work on what he likes, he has to take care of his financial coverage, because if he doesn't, he could get an assignment in a project that he doesn't like (because of the research topic) and when he is not able to find financial coverage for a longer period of time he even could get transferred to another department or get fired. From this necessity for financial coverage the researcher is willing to provide a satisfied client (social rule), involve the client in making a project proposal (social rule) and respect the client (social rule).

In addition researchers also wanted to become an expert and achieve a high level of professionalism. Therefore they had to specialize. Specialization also means collaboration – given the type of projects the groups work on – to answer the requests of clients. Working on what you like, developing a profile and reaching a high professional standard led to or affected the motive "I like to collaborate with my colleagues as they provide support". As Kevin stated: "[you need the participation of other researchers] because of the physical requirements, you can't do it all on your own, but also because you need colleagues with a special kind of expertise or educational background, colleagues who can conduct experiments, colleagues who can focus on the fundamental aspects of certain processes" (Kevin, Postharvest Group). This attitude contributed to an open position and behavior as a good colleague (social rule), involving colleagues in a project team (social rule), and experiencing a success as a shared success (social rule). Expression of this behavior led towards appreciation and the opportunity to develop a profile and a high professional standard and in doing so the chance to be involved in a next project. As Simon stated: "The most important criterion is that my colleagues are satisfied with my work. That they tell me "well you're doing some very interesting work". Besides, output is important, I mean papers to be published in scientific journals. And that colleagues approach you with scientific problems. That they recognize and acknowledge that you have a high professional standard in a field of research and that they are eager to use your knowledge" (Simon, Ecology Group).

4.4 Tensions in the practice of heedful interrelating

The social rules in general fitted with each other in the execution of activities and did not operate in a contradictory way. However, researchers did experience tensions in the design, the execution and ending of projects, related to mutual interaction, interaction with clients and interaction with management. Therefore, researchers did in a number of occasions deviate from the social rules. An example is the behaviour of Michael (Postharvest Group), especially with respect to the rules "involve the colleagues you need" and "the project leader involves his team". He stated that he did not always consult his colleagues. To our question "do you consult colleagues about the expertise required to answer a request from a client" Michael replied: "No, not in my situation. I don't know if other colleagues do. I think they ultimately do, because the project must be implemented in the end and then you have to check if the required expertise is there. For the proposals I write and offer, I do not have to consult much. I know what I can do. And whether there are people who are complementary. No, there is not much consulting [about the expertise required to answer a question from a client]" (Michael, Postharvest Group). An analysis of his involvement in projects confirmed this statement.

Another example is the social rule stipulating that researchers should provide a satisfied client. However researchers should also provide a financial result. This is particularly difficult when researchers do extra work in order to satisfy the client and in which it is unclear whether these activities should be performed within budget. Ken (Ecology Group) addressed this situation by stating: "It is hard to distinguish extras you deliver over and above the project result. And it is even harder to make a client pay for these extras. We still have the image of a research institute that delivers all that is asked for without additional budget. We have to educate our clients that we will charge them for extras" (Ken, Ecology Group). Other examples are researchers not evaluating projects even though obligatory, and the project leader ending a project on his own. The pressure researchers experienced to obey the criterion to "provide a positive financial result" was so high, that they had given up a mutual ending of projects and formal project evaluations.

In the tensions experienced by researchers, there was no expression of conflict, practices heavily debated and researchers with very different ideas on how to proceed. This suggests that the solutions achieved are not concerned with struggles, but with maintaining the status quo between opposing entities. We have not encountered completely new, radical solutions to solve these tensions, or one of the dimensions gaining so much power that the other dimension was put out of order. Therefore solving tensions takes place against the background of the established social practice of heedful interrelating.

A large number of the tensions researchers experience reflect tensions between the content of research work and management aspects, especially financial aspects. Another important group of tensions are those related to the content of research work and meeting expectations of clients. To some extent this relation was implicitly also related to the financial aspects of research work. With regard to the solutions researchers achieve, content appeared to be more important than management (or financial) aspects and solutions often (also) favoured the interests of the client.

5. DISCUSSION

This study shows that heedful interrelating as a coordination mechanism can result in a highly effective, efficient and flexible pattern of knowledge integration. Due to heedful

interrelating as a cultural coordination mechanism, the practice of knowledge integration met the three qualities defined by Grant (1996). Qualities that have to be met to create and sustain a competitive advantage based on knowledge integration. Both groups were found to have a broad knowledge base at their disposal, which was also applied as the projects that were acquired were projects that needed a broad knowledge base to provide satisfying answers (first quality, scope of integration). The practice of heedful interrelating stimulated the inclusion of the most valuable expertise in the group needed to solve the problem of the client and provided a very flexible way of making (new) combinations of expertise. We did not find particular patterns of collaboration between researchers, implying that there is flexibility in the knowledge integration practice of the groups (second quality, flexibility of knowledge integration). Our findings suggest that the practice of heedful interrelating was part of the common knowledge of the groups and that the groups often integrated specialized knowledge in projects. Due to the nature of research work and the context in which the groups operated, face-to-face interactions were an important knowledge integration mechanism. The practice of heedful interrelating made these face-to-face interactions as efficient as possible. A research group that faces the same requirements and lacks this practice, will be less flexible in making knowledge combinations compared to the groups in our study. In the absence of heedful interrelating, knowledge integration will be more expensive (as it takes more time), and will therefore be less efficient. As the groups in our study had to provide results within a (restricted) budget and within a restricted time-span a practice of heedful interrelating was responsible for an efficient and flexible way of knowledge integration (third quality, efficiency). Heedful interrelating as a cultural coordination mechanism for knowledge integration shows how the qualities of efficiency, flexibility and effectiveness can be met. This insight expands the literature on knowledge integration.

Furthermore, heedful interrelating describes the process quality with which the routine we defined as "the project life cycle" is executed and although heedful interrelating can be defined as an example of the category of (general) rules defined by Grant (1996), this local social practice illustrates that routines and rules by themselves are insufficient to explain a highly effective, efficient and flexible pattern of knowledge integration. Heedful interrelating specifies specific local circumstances and thereby provides additional insights in addition to the general mechanisms of rules, directives and routines. Our findings with regard to the significance of heedful interrelating are congruent with and extent the findings of Hoegl, Weinkauf & Gemuenden (2004) and Zárrage & Bonache (2005).

The grounding of heedful interrelating in the social rules and motives provides an explanation why the emergence of a pattern of heedful interrelating in knowledge integration is not a mere coincidence and why a group is able to design, execute and end projects during a long period of time with this process quality. Contrasting literature (i.e. Weick & Roberts, 1993; Becker, 2005) this study shows that a high level of heedful interrelating can also exist in mature groups, as the groups already exist over a period of 15 years. In addition, this study shows that a high level of heedful interrelating can emerge in a context characterized by a low degree of formalization, high autonomy, an abstract representation of the system, a combination of strong and weak task interdependency and a mutual training by participating in the practice. The contexts in which heedful interrelating can emerge, seemed to be limited to highly formalized, concrete situations in particular, exhibiting strong task interdependency and an long period of intensive training of the participants (Weick & Roberts, 1993; Hutchins & Klaussen, 1996). With regard to task interdependency for instance, Weick and Roberts (1993), Hutchins (1991) and Hutchins and Klausen (1996) can be positioned as studies

in which the actors experience strong task interdependency, as the whole crew is necessary to perform the task at hand. Our findings suggest that the task interdependency in the projects in the groups do not depend upon the involvement of the whole or almost the whole group providing specialist results to be integrated in the project. We found projects in which there is strong task interdependency, but also a number of projects in which the task interdependency is weak. With regard to the degree of formalization and autonomy, the researchers have a formal description of tasks, which defines their attitudes and actions. However how the group members perform their tasks is not prescribed by this description. They have a high autonomy with regard to the tasks they perform and how they perform their tasks. This is quite different from the situations described by Weick & Roberts (1993), Hutchins (1991) and Hutchins and Klausen (1996). Here the formal description of the tasks of the actors strongly affects their actions. As they experience strong task interdependency, their autonomy is relatively low.

Furthermore, this study provides an empirical example of a shared mental model (Druskat & Pescosolido, 2002).

Although the emergence of heedful interrelating was relatively stable, our findings also show that the emergence of heedful interrelating is not a static property or stable disposition, but an ongoing accomplishment (Orlikowski, 2002). It highlights that researchers need to be attentive continuously, in particular when they balance tensions. Although balancing tensions takes place against a background of heedful interrelating, the process of balancing tensions is not fixed in time. Researchers can also decide not to comply with the social rules. This can be a valuable contribution to the performance of the groups as these decisions can contribute to a very quick adaptation to changing circumstances in the short term. This is important as it prevents rigidity and can strengthen fit with environmental demands. We suggest that decisions of non-compliance with the social rules can also provide an incentive to adapt these rules to changed circumstances in the longer term.

Our findings with regard to the process of balancing tensions also illustrate that the collective establishment of the emergence of a pattern of heedful interrelating is not based on a situation in which all group members behave heedfully in all situations during one time span, but that the dominant pattern is a pattern of heedful interrelating. Considering it as a dominant pattern disregards the fact that some group members will not comply with the social rules or even exhibit heedless interrelating in a number of occasions during one time span. It also illustrates that it is unlikely that groups will behave completely heedfully over a longer period of time. There will be a mix of heedful and heedless interrelating. This is congruent with ideas of Swanson & Ramiller (2004) and Leventhal & Rerup (2006).

The presence of heedless interrelating next to heedful interrelating also suggests there is an optimum in the amount of heedful interrelating, as group members do not comply in all situations. Literature (i.e. Weick & Roberts, 1993; McChesney & Gallager, 2004) suggests that the emergence of a higher level of heedful interrelating and a more stable emergence of a pattern of heedful interrelating are desirable. In the field studies, heedful interrelating was linked with supplying services to clients. From this perspective, it is not obvious that more heedful interrelating is always better. Our findings suggest, that non-heedful or heedless behavior is acceptable as long as the majority of the group members, in the majority of the projects, in the majority of the situations comply with the social rules and interrelate heedfully. The quality of the product seemed to be sufficient and a higher level of heedful interrelating will make the product more expensive and it is not clear whether or not clients are willing to pay for these additional

costs. The group members worry about their competitive image related to the price of their services. This concern suggests there is an optimum in the amount of heedful interrelating from the perspective of costs and revenues. Therefore the mixed presence of heedful and heedless interrelating in the group is also related to the effectiveness and efficiency of the performance of the group.

A limitation of this study that must be recognized and addressed in future work, is that it is limited to research groups. These findings may not explain the emergence of heedful interrelating and the result of this cultural coordination mechanism for knowledge integration outside of this field of study. Yet, we did not find indications that the specific area of research of Food & Environment affected our results. We suggest to conduct more field studies to strengthen the external validity of the results.

6.   CONCLUSION

In this paper we discussed the results of a study into the emergence of a regular pattern of knowledge integration in two research groups. The study showed how a regular pattern of knowledge integration emerged through a practice of heedful interrelating in the design, execution and ending of projects. We argued that heedful interrelating was responsible for an effective, efficient and flexible pattern of knowledge integration. The grounding of heedful interrelating provided an explanation why the emergence of a pattern of heedful interrelating can exist during a long period of time. In addition we argued, that heedful interrelating specifies local circumstances and thereby provides additional insights to the general mechanisms of rules, directives and routines which cannot explain effective, efficient and flexible patterns of knowledge integration on their own. The emergence of heedful interrelating appeared to be an ongoing accomplishment. The mixed presence of heedful and heedless interrelating appeared to be related to the effectiveness and efficiency of the performance of the group.

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