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QUESTIONING KNOWLEDGE TRANSFER AND LEARNING PROCESSES ACROSS R&D PROJECT TEAMS

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ABSTRACT

This paper addresses popular notions of the generation and sharing of knowledge in organisations commonly described as knowledge transfer. We question the appropriateness of the notion of transfer of knowledge for increasing our understanding of knowledge creation and learning processes in R&D organisations. We suggest that this notion of "transfer", limits our understanding of the important interactive processes used to generate knowledge and to enhance the spread of knowledge. Findings from interviews with senior research scientists challenge the notion of knowledge transfer and instead provide support for the notion of knowledge as constructed meaning in an arena with multiple players and social interactions.

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DOES KNOWLEDGE TRANSFER ACROSS R&D PROJECT TEAMS

1   INTRODUCTION

Knowledge is a concept broader than that of information. Information can be broken down into bits and transported through information infrastructures such as telecommunication while knowledge, in contrast, "involves understanding the significance of information and its reorganisation into useful applications" (ABF, 1997: 4.2). Knowledge is multi-dimensional and distinctions between different kinds of knowledge which are important in the knowledge-based economy are know-what; know-why; know-how and know-who. Know-what can be complicated knowledge (physics) and know-why is very deep knowledge (eg, causal relationships). Other types of knowledge - particularly know-how and know-who are more "tacit knowledge" and are more difficult to codify and measure (Lundvall & Johnson, 1994).

Some theorists use the notion of explicit and tacit knowledge to differentiate between different forms of knowledge (Nonaka & Takeuchi, 1995). Other researchers differentiate between codified and non-codified knowledge, where codified knowledge is available in written documents and manuals, procedures. (Hansen, 1999) notes that one of the main problems is the *level of codification*, or the degree to which knowledge is fully documented or expressed in writing at the time of transfer between a sub-unit. "Knowledge with low codification corresponds to notion of tacit knowledge – it is hard to articulate and can only be acquired through experience" (Hansen, 1999: 87).

Models of knowledge creation and the dynamic interplay between tacit and explicit knowledge have contributed to a new understanding of knowledge (Nonaka & Takeuchi, 1991, 1995). The study of the "knowledge-creating company" has identified the important types of knowledge that are required in the workplace and the creative or generative processes that occur in the translation of one form of knowledge to another. Explicit or codified knowledge refers to knowledge that is transmissible in formal systematic language. Nonaka discusses the conversion of tacit into explicit knowledge. Tacit knowledge is personal, specific and therefore hard to formalize and communicate, as exemplified in Polanyi's words, "We know more than we can tell". The scientific community has a long interest in this field Polanyi's work is one of the foundations for more recent work investigating 'tacit' knowledge.

2   KNOWLEDGE AS SOURCE OF COMPETITIVE ADVANTAGE

Knowledge and the generation of knowledge are recognised as playing important roles in a firm's competitive advantage and economic performance (Grant, 1996; Spender, 1996). The ability of an organisation to make available knowledge from one unit to another and the take up of knowledge has been found to contribute to organizational performance although the effectiveness of this varies among organisations (Szulanski, 1996). Knowledge has been identified as a source of competitive advantage for organisations (OECD, 1996) and 'dealing with knowledge creation transfer and exploitation will be increasingly critical to the survival and success of corporations and societies' (Hedlund & Nonaka, 1993: 118). Researchers in the R&D Organisation of XEROX PARC suggest that

an organisation's innovative advantage lies in its ability to manage the flow of knowledge across its constituent communities (Brown & Duigood, 1999).

Effective sharing within organisation has been researched in areas of product development (refs) and joint ventures and alliances (refs) and the most common description is the transfer of knowledge between individual business units. The 'transfer of knowledge' is important in all organisations concerned with the generation of knowledge and the application of new knowledge in all sectors of a knowledge society.

The explicit purpose of R&D organisations is to develop new knowledge and apply existing knowledge in new ways. The creation of knowledge involves individuals, and groups or teams working together in environments which encourage and sponsor innovation. Explicit knowledge can form the basis of competitive advantage if a company is constantly ahead of its rivals with codified knowledge. The 'difference that makes the difference' (Bateson, 1972) appears to be the communication of 'know-how'.

From a knowledge-based view of the firm, knowledge is a firm's most valuable resource and is a source of sustainable competitive advantage (Grant, 1996). Grant discusses the coordination of the firm and where the fundamental task of an organisation is to coordinate the efforts of many specialists and to "integrate the knowledge of many different individuals in the process of producing goods and services" (Grant, 1996: 113).

3　KNOWLEDGE GENERATION AND DEVELOPMENT

Two widely described methods of knowledge generation and dispersal are communities of practice (Brown & Duigood, 1991; Wenger, 1998) and knowledge transfer. In this paper we concentrate on the latter and briefly describe this approach and the importance of their contributions to a broad understanding of knowledge sharing as well as their limitations. We propose that the notion of knowledge transfer does not adequately convey the processes of knowledge sharing. First we examine the knowledge transfer literature. Second, using some of the same literature cited in knowledge transfer literature, we argue for the social processes of knowledge and an interactive and integrative model of knowledge generation, building on previous research and the findings from our research in R&D organisations. Some of these differences are summarized in Table 1.

3.1　Knowledge Transfer

The notion of knowledge as transfer is in popular use (Dixon, 2000; Kogut & Zander, 1995), and a Special Issue of *Organizational Behaviour and Human Decision Processes* brings together a range of insights from researchers in the field (Argote & Ingram, 2000; Szulanski, 2000). Within these studies, knowledge is often not defined and knowledge transfer in interpreted in different ways, from knowledge that one unit picks up from another as a form of transfer (Argote, Ingram, Levine & Moreland, 2000) to a notion of knowledge transfer as a process, with stages of initiation, implementation, ramp-up and integration (Szulanski, 2000). However there seems general agreement that "Knowledge

transfer in organizations is the process through which one unit is affected by the experience of another, and is manifest through changes in the knowledge or performance of the recipient units and can be demonstrated by measuring changes in performance" (Argote & Ingram, 2000). Many of the studies assume that knowledge transfer is a straightforward process, with the little discussion of the barriers to knowledge transfer and the stickiness of knowledge are addressed (Szulanski, 1994; von Hippel, 1994).

Three recent research reports with different research on knowledge transfer are presented. Dixon (2000) looks at common knowledge in organizations; Argote & Ingram, (2000) review research in knowledge transfer and develop a framework for analysis, and Castenada, (2000) reviews the diversity of research on knowledge transfer and finds that many researcher on knowledge transfer do not build on existing approaches.

First, using a definition of knowledge as "the meaningful links people make in their minds, between information and application in action in a specific setting" (p13), Dixon takes an intra-firm perspective and examines the knowledge that employees learn from doing organisational tasks or "common knowledge", the how to or the know-how that is unique to the company. She describes the sharing of knowledge that takes place when people discuss previous practices as 'transfer'.

Through in-depth studies of several organisations leading the field in knowledge transfer, including Ernst & Young, Bechtel, Chevron, British Petroleum, Buckman Labs, Texas Instruments, and the US Army, Dixon builds a detailed picture of a range of knowledge processes, the creation of organisational knowledge, ways in which this knowledge can be effectively shared, and why 'transfer' systems work the way do. Her case studies focus on the creation of common knowledge, and the leveraging on common knowledge within a company. She describes the separate components of the transfer in terms of 1) who is the receiver: is it the same team, a similar or different small unit, or across the whole organisation? 2) what is the nature of task: is the task routine or non routine and how often is it carried out? 3) what is the nature of knowledge: assessed along a continuum of tacit to explicit.

Different forms of transfer are identified and described in some detail. The forms of transfer include *serial transfer*, where a team needs to transfer knowledge from one setting to another; *near transfer,* where a team has gained knowledge from doing a repeated task that the organisation would like to replicate in other teams that are doing similar work; *far transfer,* where a team has developed knowledge from doing a non-routine task that the organisation would like to make available to other teams doing similar work in another part of the organisation; s*trategic transfer,* where the collective knowledge of the organisation is needed to accomplish a strategic task that occurs infrequently, but is of critical importance to the whole organisation; and *expert transfer*, where a team facing a technical question beyond the scope for their own knowledge seeks the expertise of others in the organization.

Argote & Ingram (2000) discuss the contributions of articles in the special edition of OB&HDP and develop a framework of knowledge repositories in the form of members, tools and tasks. They discuss the issues in moving or modifying reservoirs and networks and conclude that further research is required into social networks. They acknowledge that

people are capable of adapting knowledge from one context to another, that people play the most crucial roles in technology transfer and recommend future research on the role of members and the sub-networks involving them are needed.

A third review of research in knowledge transfer (Castenada, 2000) concludes that studies of knowledge transfer by and large do not acknowledge each other, and she classifies knowledge transfer into cognitive, social, physical and organizational approaches. Castenada reports that the field of intra-firm knowledge transfer is an immature yet engaging area of strategic management research.

3.1.1   Knowledge transfer at the unit level

The 'transfer' of knowledge within units and across units of a company plays a crucial role in knowledge generation and the spread of ideas and technologies. Relationships between knowledge partners appear to play an important role in mediating the knowledge sharing process. Kogut & Zander (1996) suggest that more tacit knowledge is slower to be transferred and that firms tend to transfer tacit knowledge throughout the firm instead of through the market. They argue that coordination and communication build a shared identity that facilitates the development of tacit knowledge. Research indicates that the process of how knowledge is created, learned or transferred in organisations whether at the individual, collective or organisational level is a social process. These findings are confirmed by research on technology transfer from R&D research, which suggests that relationship building over time at all levels of the organisation is important as well as collaborative, jointly developed research agendas (Macleod & Shulman, 1998).

Hansen (1999) states that an important dimension is the *extent to which knowledge to be transferred is independent* or is an element of a set of interdependent components. For example a stand alone component such as software compared to when software component functions in conjunction with other components. When knowledge to be transferred is non-codified and dependent, an established strong inter-unit relationship between the two parties is likely to be the most beneficial, and a "greater motivation to be of assistance" allows for a two-way interaction between source and recipient (Hansen, 1999: 88). The main finding of Hansen's study is that neither weak ties nor strong relationships between operating units lead to efficient sharing of knowledge among them (Hansen 1999: 105). The net effect on project completion time of having either weak or strong ties is contingent on the complexity of the knowledge to be transferred across sub-units.

3.2   Knowledge Development as a Social Process of Interaction and Integration

Grant acknowledges that transferring knowledge within the firm is important and the ease that his is carried out with explicit knowledge, but he recognizes the difficulties of transferring tacit knowledge. Grant argues that the primary task of the firm is to integrate the specific knowledge of multiple individuals and that transfer is not an efficient approach to integrating knowledge (Grant, 1996). Co-ordination of the firm gains from specialization and it is not the knowledge of individuals alone but the integration of this knowledge that is important. Organisations choose various ways to coordinate, where the

type of interdependence within a task determines the mode of coordination deployed. Some of the choices are pooled, sequential, reciprocal, or group coordination through scheduled and unscheduled meetings. This latter form is most useful in group problem solving and decision-making, where "reliance upon high-interaction, nonstandardized coordination mechanisms increases with task complexity and task uncertainty." (Grant, 1996: 115).

Like Dixon, Grant's focus is on common knowledge, where at its most simple, common knowledge comprises all those elements of knowledge common to organisational members, or the intersection of their individual knowledge sets. The importance of common knowledge is that it permits individuals to share and integrate aspects of knowledge which are *not* common between them" (Grant, 1996: 115-6).

Grant summarises some of the different types of common knowledge which fulfill different roles in knowledge integration as "i) the existence of a common language, ii) other symbolic communication, iii) a commonality of specialized knowledge, iv) shared meaning where tacit knowledge can be communicated through the shared understanding between individual, such as the role of common cognitive schema and frameworks, metaphor and analogy, and stories, as vehicles for molding integrating and reconciling different understandings, and v) recognition of individual knowledge domains, where each is aware of everyone else's knowledge repertoire "(Grant, 1996: 116). In this way , reciprocal or group interdependence requires that coordination is by mutual adjustment and also requires that each team member recognizes the abilities of other team members"(Grant, 1996: 116).

Effective knowledge integration requires each individual is aware of everyone else's knowledge repertoire. Reciprocal or group interdependence, such as is found on a soccer or debating team and coordination by mutual adjustment and each team member recognizes the abilities of other team members. Grant (1996) argues that organizational capability is knowledge integration.

3.2.1 Knowledge as construction of meaning

Common knowledge as shared meaning has also been discussed by the communication theorists who contend that the belief that communication is a tool and therefore an instrument for getting your message across has led to false and exaggerated expectations about what information technology can do (Shulman, 1998). The 'transfer' metaphor assumes that communication is a tool and transmission is the process in a work group An understanding that meaning is brought about in the relationship between the reader and the information being read (Shulman, 1998) presents an interactive view. Organisations can be seen as distributed systems with and hence "sustaining a discursive practice is just as important as finding ways of integrating distributed knowledge"(Tsoukas, 1996).

3.3.2 Knowledge sharing within the context of relationships

Knowledge production is also a social process and the social production of knowledge and the effectiveness of individuals and their functioning within a social

context. Knowledge can be considered less as a product that as an aspect of practice. Much of workplace knowledge is collective: knowledge that is embedded in social activity in ways that is relatively hidden from the individual social actors (Spender 1994, 396). This collective knowledge is a dynamic concept which is not only held collectively but also generated and applied collectively within a pattern of social relationships (Spender, 1994:397).

Some of requirements for effective new product development and project team and organisation characteristics identified in previous research include the demonstrated importance of communicating across functions, having a heavyweight project leader, using overlapping development phases, engaging actively in pre-development activities, testing designed frequently communicating frequently within the team, and buffering the team from outside pressure (Brown & Eisenhardt, 1995 in Hansen, 1999: 108).

Sharing of codified knowledge takes place throughout the workplace but the focus of our paper is on knowledge embedded in practice. We contend that knowledge sharing takes place within relationships. (Castenada, 2000) concluded that interpersonal relationships are key to understanding the nuances of knowledge sharing, and the nature and frequency of interactions between knowledge source and recipients and the influence of social networks are also important. Relationships per se are not guarantees of knowledge sharing and can in fact be problematic. Some relationships between members can also be a barriers such as status differences (Leonard-Barton, 1992), interpretive barriers (Doherty, 1992) and an 'arduous relationship' can result when relationships are distant, with specific communication demands (Szulansk, 2000).

Others argue that communication within these relationships plays a critical role. Communication among team members and with outsiders improves project team effectiveness (Brown & Eisenhardt, 1995), and communication across multi-functional teams speeded up the development process (Eisenhardt & Tabrizi, 1995).

Enablers of knowledge sharing

Factors which facilitate knowledge transmission include user involvement, mutual adaptation of technology, from ongoing exchanges between software developers and end users during implementation, (Refs) Characteristics of interaction identified in research include feelings of belonging to a team, strong relationships with others, climate of experimentation, reward structures that reward joint output. Previous research has indicated the advantages of many contacts in varied areas (Granovetter, 1985) is accessing information. However, recent work comparing both gaining information and gaining knowledge may be influenced by different sorts of ties, with strong ties of importance where complex knowledge and meaning needs to be communicated (Hansen, 1999).

Different definitions of knowledge which are at times not explicit, different notions of transfer and its measurement, knowledge as embodied and embedded in networks, and tools technologies and tasks are all brough to ear on the discussion of nwoledge. Bringing together of past experiences to the current situation or context, and bringing to bear a wide range of knowledge, both contribute to knowledge generation. (Raelin, 2000) contends that

the sharing of experiences important for actors as well as recipients and reflection is necessary to convert tacit into explicit knowledge. He believes that where the very process of attempting to articulate and make sense of project experience and other interested parties helps create the narrative through which experience can be shared and preserved for future work.

Spending time together or regular meetings (Inkpen & Dinur, 1998) is important, and collaborative mechanisms with multiple iterations and feedback (Nobeoka, 1995), and face to face interactions may foster constructive interactions. Indeed lack of knowledge sharing was found to occur from a lack of meetings as well as the absence of key personnel at meetings (Hoopes & Postel 1999) and routines that were found to be barriers can be broken down by collaborative mechanisms such as focus groups.

The importance of knowledge sharing on a regular basis, with preference for face to face at team level or informal meeting situations has been noted. This is not to imply that all meetings are productive, but even monthly meetings with a changing mix of managers from all company's operations (Sharma & Vredenburg, 1998) are more productive. These findings are relevant to our investigation of knowledge development in R&D organizations

4   KNOWLEDGE SHARING IN R&D PROJECTS

In situations of research and development projects, knowledge from different disciplines and fields is applied to solve problems to create new or modified products, processes or services to meet the exigencies of a changed situation, often occur from changes in the environment.

Methodology

Our data was collected through 40 interviews with senior research scientists who were project leaders and program leaders across newly created business units of the State Government Agricultural R&D organization during a restructuring phase. Restructuring of the organization from specialist research units into business units increased the knowledge domain, broadened the arena of the variety of backgrounds of participants, at the research program level focus on strategic as well as operational issues. Research scientists were widely dispersed through out the State and often worked on similar projects but in quite different locations which assisted in providing information about which types of environments and conditions were the most productive.

At the strategic level, a Board structure was established with input from business people, value chain representatives as well as scientists and producer organisations with requirements to act using a business approach with increased financial accountability. The research scientists at the production end tended to continue with their research as before, but the restructuring set in place processes that enriched the discussion and planning of research by bringing them together on a more regular basis and focusing them on the nature of their new unit. Many of these scientists had worked for the larger organization for a long time. Many had worked together on different projects in different locations. As

individuals they were highly committed to their research as well as to their customers who were often grower associations.

Knowledge sharing in relation to R&D projects was shown in a number of ways. Some researchers gave examples of how knowledge that had gained in one area could be applied in a different situation. Within projects knowledge sharing was increased through co-location of scientists from a variety of fields, not just in the same city but on the same research station.

> *The key to it all was I recognised that all the key scientists involved, a breeder, a plant pathologist, an entomologist and extension officer were all compatible….. And I got the team together because I just figured it was a compatible team and it has proven very much so…. I actually transferred the breeding team, the breeder and his technician up from one research station and I was able to put them altogether at one site, at the research station*

Regular meetings were scheduled for project teams to maximise the creativity of the team, resulting in better discussion and richer ideas.

> *We have regular meetings every fortnight. We organise our projects together as a group, as a team. And we have people who work on more than one project. We purposely avoid the one scientist, one technical officer, one project syndrome, which fosters tunnel vision, it fosters competition for resources and all that sort of thing. We try to avoid that. And by having meetings and having people work together, we use the creativity that's in the team. I could give you a big long list of the benefits and as I said, all the projects are organised so that we work together.*

Planning meetings for project teams involve the whole team, from the beginning ..

> *And the other thing we do, next week in fact, we're having a second strategic planning meeting. We had one two years ago. We've got a strategic plan and we will update that.*

At the program leader level, meetings are held with leaders of research programs across all projects every four to five weeks. These meetings are businesslike but often display friendly rivalry.

> *Well, with the other program leaders, we meet regularly and fight over money (Laughing). There's a lot of interaction on resource sharing in projects and staff movements. There is really no one centre that is all one program, even though a program dominates, therefore there is constant staff sharing, which equates to money sharing eventually, project organisation, shifting expertise and resources. So there's this constant sort of dynamics between the program leaders of how I can best get a bit of R&D done and it may be by shifting resources from another program leader. So there is a tremendous amount of that sort of dynamics goes on with people, money, facilities, resources and then of course we all come together to do the planning phase. That's all*

operational, where we have this constant interaction, but then as a unit, we do the planning together.

Other examples tend to show that when people come together on a formal and individual basis there are added knowledge benefits. The common thread is the diversity of specialized discipline of the scientists and their joint knowledge sharing and problem solving, integration of different perspectives not only knowledge transfer.

Discussion

Knowledge sharing processes are conceptualised in different ways within different situations or contexts. In communities of practice, people are socialised into certain behaviours and practices in relatively stable environments. In a transfer model, people may come together with the explicit purpose of passing on knowledge to others on a task basis or through rotating personnel.. In the interactive integrative model, experts from multiple backgrounds come together to solve problems, to plan and work together. Each person brings a repertoire of knowledge and experience that is required for creative solutions. A comparison of these models and their characteristics in found in Table 1.

Insert Table 1 here

Conclusions

The notion of transfer is embedded in discussions of knowledge sharing within and between organizations and clearly applies to the passing on of codified knowledge. Our findings from our research and from literature regarding the situation of group problem solving suggest that an understanding of knowledge generation as an interactive and integrative social process is required.

The notion of transfer could be more accurately applied if the diversity of work on the dimensions of relationships which facilitate knowledge sharing is synthesised and then used as a framework for systematic investigations of knowledge generation in R&D organisations, firm competitive advantage as well as alliance formation and management. Clear elaboration of the processes in interactive knowledge exchange and development will lead to further research into these characteristics.

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	COMMUNITIES OF PRACTICE	TRANSFER MODEL	INTERACTIVE INTEGRATIVE MODEL
Purpose	Pass on knowledge and expertise, Perhaps apprenticeship	Pass on knowledge Sender & Recipient	Participants with expertise in multiple areas mutually engaged
Roles	Community of performers and learners	Expert role Recipient role	All members have some valued expertise
Forms of communication	Primarily face to face	Multiple channels include face to face	Primarily face to face
Source of knowledge	Work together, well developed practices and processes	Internal and external sources	Work together to solve new issue, resolve problems or explore ideas
Environment	Known ways of working	Fertile or barren	Contribution of all valued
Expectation	Performance maintained with some benefits	Performance affected by other's knowledge in predictable way	New performance shaped by input from all
Boundaries	Relatively fixed longer time often focused on singular product or service	Specific practices	May be project or program based
Relationship	Necessary. long standing, over time	May be short-term Not necessary	Necessary for planning, participating, review, action
Relationship factors	Personal relationships develop over time Joint enterprise, mutual engagement, Shared repertoire Reciprocity and trust	Relationships improve transfer	Importance of personal relationships Strong ties Trust

Table 1. Characteristics of models of knowledge sharing