Diversity and knowledge sharing: an analysis of integration processes in Multinational Firms (MNFs)

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Synopsis
Purpose – Corporate R&D internationalization is today perceived as a strategy intended for enhancing the knowledge of large firms within a highly-polarized global cognitive space. Two main questions arise and, as such, are incorporated as the two complementary themes of our contribution: what are the risks of wasting resources used by MNFs when they establish or take over laboratories abroad? What strategies do they apply to harmonize relations between their various R&D entities and, as such, help reduce these risks? **Design/methodology/approach** – The analysis is developed from a base comprising international cases, established within the R&D laboratories of multinational firms. **Findings -** R&D internationalization strategies generate a great diversity of knowledge. Consequently, these MNFs should develop inter-entity management skills, for which we provide a few of the keys to success. **Research limitations/implications –** The factors determining the effectiveness of the articulation of knowledge sharing systems were not really part of any systematic analysis. Such an analysis would have been an opportunity to specifically appraise this. **Originality/value** – Our approach could indeed improve social interaction-related issues. Our results may greatly add to social interaction theories by attempting, above all, to enhance "sender - receiver" type models, on a MNF network scale (Gupta and Govendarajan, 2000, Noorderhaven and Harzing, 2009).

Keywords: Knowledge sharing, diversity, integration, innovation networks, social networks, R&D internationalization.

Multinational firms (MNFs) R&D strategies provide us with an extensive scope for analyzing knowledge management systems' integration practices. In a race for innovation, the processes implemented for identifying and for sharing technological knowledge are vital. When this knowledge depends on extremely varied creation and capitalization procedures, as is the case when a firm establishes its R&D laboratories in many different locations, it is beneficial to be able to take advantage of organizational resources wherein information may be cross-checked and critical knowledge accessed. MNFs are directly concerned by this situation as they continue to set up Research and Development (R&D) laboratories outside their countries of origin as part of the race for innovation on a world level (UNCTAD, 2005; Sachwald, 2008). This international layout tends to generate a wide range of practices which, over time, become tricky to coordinate together when wishing to carry out innovational projects (Benveniste, 1994, Becker, 2001, Lahiri, 2010). Establishing a R&D entity in another country means immersing oneself in a specific localized social network. And, having a variety of locations may result in a dispersion of resources.

Paradoxically, this question is borne by distinctive research issues. On the one hand, some research assesses the reasons for R&D internationalization and specifies the conditions required for integrating innovational social networks (Kuemmerle, 1997, Thévenot, 2007), whilst other deals with the conditions that facilitate knowledge sharing within MNFs (Noorderhaven and Harzing, 2009). Yet, the particularities of participating in different innovational social networks leads directly to questions on MNFs absorbing knowledge. The answer to the question of what are firms looking for in these locations, what cannot be moved but yet is so important for their development, may actually consist in assessing the very notion of knowledge. By differentiating codified knowledge and uncodified knowledge, in particular tacit knowledge (Polanyi, 1967), the knowledge economy links potentially instantaneous mobility to codified knowledge. Information is disseminated but not knowledge which, is, to a certain extent, specifically appropriated by organizations and individuals. Tacit knowledge sharing is, as such, bound by relations that are based on proximity and recurrent direct contact. For a MNF, localizing a R&D laboratory abroad is the only way to appropriate tacit knowledge that can only be comprehended by being on-site and by integrating networks that are based on a given proximity (Jacquier-Roux and Le Bas, 2008). The question is then asked about actually succeeding in integrating these various networks; something which could lead us to link the two issues more closely together.

In this sense, recent work that emphasizes that if a MNF wishes to improve its technological knowledge base, it must, nonetheless, seek to limit risks of dispersion. These risks may be curbed in two ways: through the technological diversity that the firm has already acquired and through the scope of its inter-entity integration (Hansen et al, 2004, Lahiri, 2010).

We have decided to explore the second perspective. Classical studies, which link entity differentiation and integration procedures together (Lawrence and Lorsch, 1967), provide the opportunity to associate the issue of cognitive resource diversification (integrating localized networks, recruiting researchers and engineers, technological partnerships) with that of MNFs integrating knowledge flows. Likewise, other classical studies (Goodman et Sproull, 1990) justify the interest of linking together the study of the firm's external and internal networks. A study relating to knowledge sharing within MNFs should be able to associate the characteristics of innovational social networks with those of intra-firm networks.

First of all, we develop the assumption that the R&D internationalization of firms can be deemed a means for sharing tacit knowledge within networks based on a given proximity. We illustrate how such an approach raises fundamental questions on knowledge absorption.

Secondly, we discuss the methodology established in order to study a group of MNFs that are directly involved in such an approach. In this section, we present the analytical dimensions of knowledge sharing. The third part of our work analyzes how these firms succeed in sharing knowledge throughout their various entities. The factors that help reduce the risks of dispersion are within the intra-firm network and are dealt with in a detailed presentation.

1. R&D LOCALIZATION, INNOVATIONAL SOCIAL NETWORKS AND KNOWLEDGE DIVERSITY.

If knowledge focuses on the context of its creation and development, it is therefore clear that the more diversified these contexts are, then the trickier the procedures for mobilizing this knowledge will become, as they are qualified within these various contexts. In practice, these contexts are represented by social networks composed of different resources and actors, which we can qualify using two elements: technological wealth and diversity (Almeida and Phene, 2004). We begin by justifying this approach by developing an epistemic idea of knowledge before going on to develop the procedures for creating and disseminating this knowledge, as seen from a MNF perspective. We conclude with the risks presented by the diversity of knowledge and networks, which are its melting pots.

1.1 The dynamics of knowledge development

According to cognitive psychology, knowledge is defined as structures that are stabilized as long-term memory, structures that form the basic knowledge for the action and for understanding messages and situations (Crépault and Nguyen, 1990). In the field of management, a "hierarchical knowledge view" was able to make the distinction between data, information and knowledge. If the information activity consists of a data interpretation process, the activity of gaining knowledge lies within information interpretation and contextualization (Davenport and Prusak, 1998). This approach was taken into account in a majority of studies, which tackled one of the analytical frameworks, referred to as "conversion modes", established by Nonaka and Takeuchi (1995). This analytical framework, which has become a central benchmark, was applied by prioritizing the objective of knowledge dissemination to the expense of praxeology, i.e. the action of individuals and groups (Cook and Brown, 1999). Today, we are rediscovering the difficulties related to knowledge conversion. Interactions are not without their share of challenges, in particular in the world of design and R&D: their abstract character and the importance of tacit knowledge mean that statements are ambiguous (Duguid, 2008). The importance of tacit knowledge is, as such, marked. Tsoukas (2003) made a radical criticism by stating that tacit knowledge cannot be appropriated, cannot be transferred and cannot be converted. It appears in contexts, it is coproduced by actors, present in these contexts, and undergoes perpetual formation and reformation. It remains tacit, it accompanies and reinforces the production of codified knowledge, but it is never part of a codified knowledge conversion process. This does not exempt the actors from working to improve the systems that are likely to produce knowledge by applying the best social interactions, concerned with *care*, according to Von Krogh (2003). It would, however, be illusory to attempt to "operationalize" tacit knowledge by making it "more codified".

The main interest of this critical approach is to heighten awareness of the idea that the systems implemented for creating knowledge are more important than the knowledge itself. Moreover, not all the systems are necessarily explicit. The aim of specific research work may aspire to analyzing the ways these systems, formed by knowledge creation social networks, exist and operate.

From this point of view, it is extremely interesting to analyze knowledge transfers from the smallest possible level (two protagonists). Analyzing transfer attempts between an expert and a learner, Brassac (2000, 2003), defines knowledge acquisition as a process in which two actors, at least, are co-responsible for generating knowledge in order to assume the transfer. This process is implemented in a set of social interactions, formed by discursive exchanges, gestural productions and by handling equipment. As far as the actors are concerned, their aim is to perpetuate these interactions as they form the relation that provides the opportunity to exchange information, which in turn, helps create knowledge. Under such conditions, and, strictly speaking, no knowledge transfer exists. Instead, a joint construction of significations, intended for being used and appropriated by the learner during post-acquisition, is developed. This micro-analysis throws some light on our research into the ways innovational social networks operate. It highlights the interest of taking relational systems into account at least as much as their products, in the form of knowledge.

1.2. Coordinating four networks for sharing knowledge within the MNF

How is this issue of information transfer and knowledge creation implemented at MNF level? Most studies suggest that this strategy contributes to the overall learning process in large firms, whether it may be for exploiting knowledge on new markets or for exploring cognitive fields that are yet poorly represented in their country of origin (Kuemmerle, 1997; Patel and Vega, 1999; Le Bas and Sierra, 2002; Thévenot, 2007), on the contrary, managed at a level of excellence in other countries. This being so, these firms assume the risk of transferring some of their knowledge to those countries where they establish themselves, in exchange for initiation that they aspire to accomplish (Criscuolo, 2002). Another risk, however, exists within the MNF itself. If a firm wishes to improve its technological knowledge base, it must, nonetheless, seek to limit risks of dispersion. A firm can have R&D entities that are closer to its rivals' entities than to its own entities. In certain sectors (for example, automobile), firms manage to establish vertical clusters, which tend to specialize their relational capacities (Dunning, 2001, Colovic and Mayrhofer, 2008). Internal knowledge sharing barriers may develop and hinder the success of innovation processes. The quality of the innovation (measured by the number of patents) may be impaired by an overly high dispersion of R&D activity off-shoring (Lahiri, 2010). There is a high risk involved when R&Ds wish to internationalize. This risk can be divided into risk classes: the duration and cost of identifying knowledge that is useful within the multinational network may be high, knowledge transfer from one entity to another may be tricky and, R&D entities, which are too dispersed, may disappear as a result of an accumulation of the first two risks (Lahiri, 2010).

In practice, a MNF has to coordinate four types of R&D networks. This provides us with an initial approximation as to the diversity of the systems implemented for developing technological knowledge.

Table 1. Diversity of firms' globalized R&D networks

Distance indicator	Laboratory relations with the local overseas country where	Laboratory relations with actors, who are geographically

Internality indicator	it is established	very distant
Laboratory relations with the firm’s other entities	**Local intra-firm network**	**Global intra-firm network**
Laboratory relations with actors, external to the firm	**Local external network**	**Global external network**

Source: according to De Meyer, 1993 and Jacquier-Roux and Le Bas, 2008.

Each network is comprised of knowledge sharing systems that are adapted to the type of knowledge produced in the network: intellectual property rights, contracts, and informational media for codified knowledge; given proximity, culture and collective practices for tacit knowledge. Based on this, the MNF organizes the architecture of its knowledge production system and assigns specific and potentially evolutionary roles to the central laboratory and to the laboratories abroad (Zander, 2002). Lahiri (2010) in particular illustrates that the performance of the organizational and cognitive links of the global intra-firm network helps prevent laboratories abroad from immuring themselves in local dynamics, which are detrimental to the effectiveness of the R&D internationalization strategy. If a firm wishes to improve its technological knowledge base, it also implements at least four knowledge creation processes, which may, over time, turn out to be tricky to coordinate. This strategy is very risky for a multinational firm. Local partnerships can separate the different units from each others.

1.3. Localized tacit knowledge coproduction

A MNF tends to steer its R&D localization strategy in relation to the improvement it hopes to make in its technological knowledge base, and also in relation to the ability of its global intra-firm network to absorb knowledge and to share it throughout the various local intra-firm networks. To do this, when it has spotted a location, it cannot hope to absorb tacit knowledge by simply using the mechanisms of the market: it can only try and penetrate this pool and take part in its production. The firm cannot merely steer its action to the market transaction area, it also develops as a hierarchical entity and a knowledge exchange and creation entity (Amesse et al, 2006). In other words, what is local, and what must be gleaned on-site through R&D internationalization, is not tacit knowledge as such, but the localized and non-transferable processes of their coproduction, which the firm wishes to participate in. There are several ways for a MNF to do this. We can mention researcher mobility, by recruiting the best elements spotted. Yet, it is not just a simple job of recruiting researchers on-site, the MNF needs to establish itself locally so that these researchers remain within their network (David and Foray, 2002). As the researchers recruited also access the MNF's global intra-firm network (table 1), they extend their social network, and the MNF can, over time, link its global intra-firm network to the local external network that it has penetrated.

A second, more general, approach consists of initiating a territorialization process. This includes both localizing and participating in the local dynamics of tacit knowledge production. Territorialization is based on strengthening the local links of each laboratory researcher's social network (Allison and Long, 1987). Likewise, the institutional network of the laboratory abroad consolidates its local base through a territorialization approach (Saxenian, 1994). Through the researchers' interpersonal relations and through the local technological platforms, clusters and other local scientific collaborations with universities, rivals and customers, the laboratory abroad gains access to given processes where tacit knowledge is produced, within an atmosphere of reciprocity. Because each localize social network offers specific qualities for creating knowledge (Almeida and Phene, 2004). These qualities play a role in the creation of "geographic communities" (Almeida and Kogut, 1999). Based on an empirical study of patent data for semiconductors in the United States, we can illustrate that the intensity of patent filing is highly correlated with the rate of the intra-regional mobility of engineers. If the MNF wishes to develop a local external network, it must invest in a sustainable localization and practice sharing process.

Such a process can be illustrated, for example, by the development of smart power research in the Toulouse region of France. Several major industrial establishments are working together on these activities: Aérospatiale, Alcatel Space, Alsthom, Bosch, Matra, Siemens, Thales. Motorola set up business here in 1967; it was managed by an academic for 12 years and 70% of the engineers it recruits are graduates of local schools. These different firms have created numerous links with academic partners (CNRS laboratories, engineering schools, universities). To take advantage of locally-developed resources, Motorola decided to intensify its relations with a CNRS laboratory: the LASS (Laboratory for Analysis and Architecture of Systems). A joint laboratory was created in 1995 (Power Integration and Sensors Laboratory). Research is carried out jointly by teams comprised of staff from the firm and LAAS researchers and doctoral graduates. So that the partnership programme would be a success, the firm had to convince its partner that its intentions were serious, by providing it with confidential information. This required a long period of negotiations to, as the partners say "establish favourable conditions for developing the ideas freely". The joint laboratory is bilocalized: each project is materially carried out either in the firm or in the LAAS, which provides its expertise in partnering, developed with other industrial groups. The project leaders, selected from within both structures, are responsible for managing the project. A shared knowledge base has been developed. Relations are interpersonal ("we see each other regularly" say the partners), and are generally initiated by a doctoral graduate who is the link between the stakeholders; doctoral graduates are subsequently employed by the group (1/4 of engineers who work on subjects that concern Motorola come from the LAAS).

And, last but not least, knowledge sharing within localized innovation networks is highly similar to the way communities operate, in their cognitive dimension (Brown and Duguid, 1998, 2001; Lave and Wenger, 1990; Wenger, 1998). The dichotomy between explicit knowledge and tacit knowledge needs to be surpassed. Tacit knowledge makes knowledge actionable and operationalizable by creating an interdependence between the "know how" and the "know what". The "know how" is defined as "the provision that enables the know what to be applied". The analysis of the most codified scientific statements shows that they take time and are costly to produce in particular because of the need to develop a lot of intermediate knowledge (the "know hows"). Scientific knowledge is based on intermediate tacit knowledge. Consequently, coproduced and shared tacit knowledge should be conceived as being just as much a part of the technical register as a part of the aptitudes and behaviour register, which prioritizes learning (Simoni, 2005).

1.4 Ensuring inter-entity transfer by meeting the "decontextualization – recontextualization" challenge

If R&D and innovation processes become established in localized social networks, then the MNF must take advantage of the knowledge that is created there so that it may be shared with other entities that are likely to be interested in its potential. Although it is rather easy to state this objective, it is, nonetheless, extremely tricky to implement it. The reason lies within this link between the "know how" and the "know what", which means that knowledge cannot be transferred as it stands from a public laboratory-firm platform to a firm entity and then on to another entity in the global internal network. Knowledge, which does not exist in a raw, natural state but which is composed of questioning that initially inspired it, multiple interactions that enabled it to come into being and tacit rules that assembled it, cannot be decontextualized and then recontextualized without losing its sense and its operational capability. Notwithstanding, information can be produced from created knowledge, and can act as indicators (and only indicators) and be transferred between MNF entities.

The question that then presents itself is that of the firm's integration ability. If the firm wishes that "locally" absorbed knowledge is used and developed on "inter-entity" bases within it, then a learning curve must be developed locally and between the various MNF entities (Hansen et al, 2004, Venaik et al, 2005). The relevance of the information produced and the quality of the transfer of the information are related to the ability of the firm to informally share the experiences developed on local bases (Gupta & Govindarajan, 2000).
The aim is to make it possible for researchers and engineers to rapidly access information that is likely to enhance their acumen and facilitate their search for information (Frost and Zhou, 2005, Lahiri, 2010). The aim is also to develop sharing attitudes and behaviour within the various entities. Knowledge sharing can, as such, be conceived as the result of the different capacities of the firm to organize links between the various entities and to ensure they are integrated.

2. METHODOLOGY FOR ANALYZING SYSTEMS FOR CAPITALIZING KNOWLEDGE

The quality of inter-entity links may be analyzed at several levels. We will study the links developed within both local and global intra-firm networks. We will build on several international studies that we participated in at the beginning of the 2000s (Mendez, 2000, Verdier, 2001). We will firstly present the methodology of these studies and then specify the analytical scope for the systems for capitalizing knowledge.

2.1 Methodology

We carried out three series of studies in six developed countries as part of a European research group (Appendix 1). Each study focused on a sector that was highly involved in creating new technological knowledge (IT, telecommunication and pharmaceuticals). In each country, at least one national firm and one firm of foreign origin participated in an in-depth case study. These studies in their entirety are available on www.equi.at/dateien/**sesi**finalreport.pdf. A methodology was developed so that the most significant aspects of knowledge sharing within the MNF could be highlighted. As the assumption had been made that the systems and the social networks were at least just as important as the knowledge created, it was essential for each of the management tools, as well as the practices within the R&D laboratories, to be given potentially strong roles.
As such, several conditions were defined: a sufficiently long stay in each of the MNF's research laboratories (more than one year), assumption-free analysis carried out a priori in compliance with the position of established theories and a priority given to the process study

and to the case study. The approach adopted is inspired by the principles of the established theory as it was developed by Glaser and Strauss (1967). Although data collection was based on preliminary theoretical constructs, its aim was not to test the assumptions, but to group together the factors that would offer the opportunity to debate available theories and, possibly, formulate new proposals (Strauss and Corbin, 1994). The process study (Mohr, 1982) that we prioritized enabled us to envisage the articulation of diverse dimensions of management by seeking to identify the various events that would allow knowledge sharing between the different entities. We prioritized the study on management processes where practices for creating, capitalizing and for disseminating technological and social knowledge are structured in a non-exclusive way. Finally, the case study was favoured so that the knowledge systems of each of the organizations studied could be established. The objective of this type of study is to carry out an in-depth analysis of a unique situation in relation to numerous dimensions (Stake, 1994; Yin, 1984).

In each case, the data collection was organized, firstly, through documentary reviews and informal interviews held with the main company managers and secondly, through semi-directive focused interviews (15 interview averaging two hours per firm) aimed at developing the role played by each dimension. Interviewees were chosen from two categories of executives and employees: those directly involved in knowledge creation (project leaders, technological partnership managers, engineers), those in charge of knowledge capitalization (information systems directors, intellectual property managers, technological and/or business group managers, human resources management).

2.2 Dimensions for analyzing systems for capitalizing knowledge

The term that best describes the knowledge management practices of MNFs' laboratories is capitalization system. We made this the focal dimension of our analysis. The notion of a system stems from that of cognitive systems defined by Poitou as intellectual sets of finalized and organized objects, linked together and disseminated in space in order to produce goods or knowledge (Poitou, 1997). The cases established allow us to identify several systems for capitalizing knowledge. These systems are, above all, organizational systems that group together management tools, linked together and disseminated within the organization, whose aim is to facilitate knowledge creation, capitalization and dissemination. Not all the management tools, comprised in such systems, are responsible for managing knowledge directly or exclusively. Yet, because they exist in the organization space, they are likely to be used for this even though they were not designed and implemented for this purpose. Linking tools within a system and then linking the various systems within an organization is a practical question that raises fundamental design and implementation issues. The various systems are presented in Table 2.

Each system is influenced by the diversity of management tools that structure it. Some of these tools are formally designed for capitalizing knowledge and for sharing it. Other tools are used in a derived way to disseminate the information: to facilitate the preparation of a project or to consolidate an engineer's knowledge. It is the coexistence of these various systems and tools that can facilitate, or not, entity integration.

For the purposes of this article, we can only present a few examples. Some systems are implemented to capitalize knowledge whilst others do likewise, but indirectly or in a roundabout way.

Large-scale MNFs use technical databases and project management tools to establish the conditions for regularly transferring knowledge between the different entities. In subsidiaries, project managers are responsible for applying the procedures and for transferring them to the "project leaders". Electronic documents, relevant to each project, are transferred between the different project departments so that project progression and results may be shared. These documents are centralized by the project steering department which, firstly, compares the effectiveness of each project in terms of time, cost and technical quality and, secondly, identifies the production of new scientific and technical knowledge.

Table 2 – Systems for capitalizing knowledge and their tools

Systems	Management tools	Aims
1. R&D structures	Task assignments Gatekeepers R&D information system	To organize R&D To centralize and disseminate information To facilitate internal and external collaboration
2. Experience codification	Project management Technical databases	To homogenize through technical information Technical documentation for R&D work Product development documentation
3. Technical communities	Forums Internal benchmarking	Technical upgrading Technological heritage management
4. Skills appraisal	Project manager appraisal Annual appraisal	Skills management

	Promotion on a technical level Quarterly interviews	

The tools specified in the table are not the only ones to play a role in knowledge capitalization. Other tools contribute by creating systems that are totally complementary or, occasionally, rival. At this stage the research question can move from the integration of the different units to: how links are established between these systems and how can we clarify the quality of the links inter-units.

3. KNOWLEDGE DIVERSITY MANAGEMENT AND SYSTEM INTEGRATION

The systems that we have identified constitute the infrastructure for the links, which can be more or less significant and which can develop between entities (between R&D laboratories, between laboratories and production entities). These systems are connected in different ways (3.1). Without systematically assessing the effectiveness of the links, we present an analysis of the main factors applied for integrating the systems (3.2).

3.1 How systems for capitalizing knowledge are connected

Tools and systems produce information about scientific and technological knowledge, but they are unable to link together alone. This information may be linked by individuals who are simultaneously part of several systems. Strategists have often substantial seniority in their field, they manage R&D departments and create technical communities. This linking role seems to fit them perfectly.

The definition that comes closest to the "technical communities" system is that of research clusters provided by Callon (2003). The technical communities of a firm have a power that frequently conflicts with strategic guidelines. In this case, professionals capitalize the knowledge that they produce for themselves, they disseminate it within specialist circles, in a context that is more dominated by scientific progress than by the projects of the firm. Corporate management can take advantage of these communities by fostering exchanges and or by facilitating community fulfilment. In an electronics and telecommunications MNF, the technical community is instituted and comprises 300 members. It is organized by fields of expertise so that scientific and technical knowledge may be capitalized. Community members are consulted by corporate management when programmes and projects are to be chosen; they also establish engineer promotion committees based on the technical scale. The members define their own procedures for capitalizing and for sharing knowledge, using their information relays in the various entities (managers of entities or of technological groups and project leaders). The community operates through meetings, technological forums and electronic exchanges.

Notwithstanding, intermediate managers also have a key role to play in he articulation of the different systems (Simoni, 2008). As project leaders, technological group managers or members of technical communities, these managers come into contact with contexts where knowledge is created. They strive to solve conception-related issues hand-in-hand with their teams; the purpose of their interventions is to bring knowledge requirements and sources closer together.

So, at what level are the links made? Systems are basically linked together by managers during meetings: appraisal committees, forums, technical community assemblies. For example, skill appraisal tools bring together a wide range of actors and a great variety of management processes. These tools are mainly dedicated to running the human resources management system (appraisal, remuneration, promotion). Several managers are concerned with their application: HR managers, project leaders, technological programme managers, technical community members. These appraisals are linked together specifically by functional managers rather than by databases. As such, they make a significant contribution to knowledge sharing.

Notwithstanding, it is the organization as a whole that potentially represents the overall space for linking tools and systems. This observation raises the question of organization conception and can be considered similar to the “middle-top-bottom” model established by Nonaka and Konno (1998). The aim is to initiate awareness within the organization to exploit all possible opportunities to spread the experience.

How are these links made? Intermediate managers, who are the most involved in these exchanges, have the privilege of participating in several knowledge creation and capitalization spaces. They are the most called upon for linking other actors and the tools that they deal with. As such, the articulation of the various systems depends on the quality of the relations developed, on the one hand, between intermediate managers and, on the other hand, between these same managers and the other actors involved in conception projects and in business channels. It is, therefore, the expertise of the intermediate managers that seems to be the key lever for articulating the systems. It is the memory of these managers that guides their actions when they come together during a technical-level engineer promotion committee or in a forum, where they assess the different proposals of the day. Links between systems are established essentially through the managers' ability to create relations between knowledge sources and latent requirements.

3.2 Factors for intra-firm networks to operate successfully

Four determinants of effectiveness can be highlighted in system articulation: information sensor redundancy, the diversity of the actors, opportunities for discussion and long-term durability.

Information sensor redundancy is often presented as a factor determining the reliability of control systems. The various management tools implemented within each system produce information on the same knowledge. This can be seen, for example, through the results of a technological exploration that are recorded in a database, that are also collected during project experience feedback and that can be presented during a technological forum. The diversity of the actors (heads of project management, scientific and technical information specialists, technological group managers, forum coordinators, human resources managers) is another decisive factor in knowledge capitalization processes. This diversity concerns the ways in which knowledge creation and dissemination are approached. It enhances knowledge capitalization processes.

The third factor reinforces the opportunities for redundancy and diversity. It concerns the meeting and discussion opportunities open to intermediate managers who are effectively organized to facilitate exchange between the various capitalization approaches. Forums are one of these areas for exchanging and debating on the technological developments that should be favoured. The various appraisal and promotion interviews also enable intermediate managers to work together around the experiences provided by the R&D employees. The fourth factor for success concerns the long-term durability of the first three factors. Redundancy, diversity and areas for discussion cannot be effective unless they are sustainable. Sustainability stabilizes relations and establishes anchor-points for gathering information.

3.3 Discussion

Each case that provided us with the opportunity to assess the effectiveness of the articulation between the systems was validated by the managers to whom we presented the results. Nevertheless, it is essential to mention the external validation of our study. Although they have been detailed, the factors determining the effectiveness of the articulation of knowledge sharing systems were not really part of any systematic analysis. Such an analysis would have enabled us to assess precisely the role this articulation could play as regards the quality of inter-entity links and, by deduction, as regards local and global inter-firm network effectiveness. As our approach was not based on a knowledge flow analysis, but focused on the quality of the articulation of knowledge sharing systems (Brassac, 2000, Tsoukas, 2003), it is likely to enrich the issues relating to social interactions. Our results may greatly add to social interaction theories by attempting, above all, to enhance "sender - receiver" type models, on a MNF network scale (Gupta and Govendarajan, 2000, Noorderhaven and Harzing, 2009).

Conclusion

By being interested in knowledge, not as flows but in terms of resources managed by organizational systems, offers the opportunity to refine the analysis of the sharing procedures implemented within large-scale organizations and, in particular, MNFs. By relating the issues of innovational social network integration and those of inter-entity integration, we did not deal with two separate questions, but with processes which are intimately inter-dependent. Although it is clear that MNFs set up laboratories abroad to be able to penetrate tacit knowledge exchange networks that are founded on a given proximity, it is also just as clear that the ability to manage the diversity of organizational systems is necessary. We emphasize the fact that two knowledge sharing movements require coordination.

In the first, the diversity of knowledge required to nourish innovation projects is fulfilled. This diversity is accompanied by segmenting knowledge management into several systems, each responsible for a specific part of the knowledge (explicit/tacit or codified/contextual).

Secondly, the systems are coordinated using different procedures. The complexity that can develop within the organization may be highly significant. A few apparently simple principles can regulate the wide range of coordination between the various sub-systems that are used. We have defined these principles as factors for sharing knowledge successfully.

Finally, we propose to acknowledge that tacit knowledge is coproduced with the actors of given proximity networks rather than being exchanged with them. As such, the analytical purpose is no longer the tacit knowledge for which we followed the movement, but the processes of coproducing and sharing this knowledge, where MNF resources have a role to play. With this in mind, the trust that is put into the human relations of the knowledge creation and sharing systems seems decisive.

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Appendix 1

Case studies

Country / Sector	IT (industry and services)	Telecommunications	Pharmaceuticals
Austria	Siemens AT&S	Ericsson Kapsch	Igeneon IMP Bender
Germany	Agilent Technology SAP	Lucent Technologies Nortel Dasa Alcatel Research Center	HMR Aventis Merck KgaA Atugen Berlin
France	Canon Bull Inria Spin off	Motorola Alcatel Space SCM	Hoescht Marin Roussel Rhône Poulenc Rorer Fabre
Portugal	Neuronio Critical Software	Alcatel EID ENT	Jaba Horvione
United Kingdom	ICL Hewlett Packard Signal	Racal Electronics Nortel Science Park	Pfizer ICI Oxford Glycosciences
United States	SAP Labs Agilent Technologies Force Computers	Lucent Technologies/ Bell Labs Alcatel USA Nortel Networks	Aventis Atugen Sugen Inc