

SPACES online

Spatial Aspects Concerning Economic Structures

Johannes Glückler

Islands of expertise –
global knowledge transfer
in a technology service firm



UNIVERSITY OF
TORONTO



RUPRECHT-KARLS-
UNIVERSITÄT
HEIDELBERG
EXZELLENZUNIVERSITÄT

Issue 2008-03 | Volume 6
www.spaces-online.com

Please quote as Glückler, J. (2008): Islands of expertise – global knowledge transfer in a technology service firm. SPACES online, Vol. 6, Issue 2008-03. Toronto and Heidelberg: www.spaces-online.com

Author Johannes Glückler, Department of Geography, University of Heidelberg, Berliner Str. 48, 69120 Heidelberg, Email: glueckler@uni-hd.de

Keywords knowledge transfer, transnational corporation, social network analysis, geography of the firm, know-who

JEL codes A14, C45, L14, L25, R11

Abstract

This paper conceptualizes knowledge management in a trade-off between geographical distribution and organizational coherence. It focuses on an extensive corporate case study of a globally distributed medium sized technology service firm to explore the constraining and enabling conditions of interpersonal knowledge transfer. A social network analysis visualizes the architecture of knowledge flow and assesses its vulnerability. Moreover, it shows that geographical separation and status dissimilarity are key barriers to knowledge transfer. Expatriation programs are found to be the most effective driver of international interpersonal knowledge transfer.

Acknowledgements

This research has been funded by the German Research Foundation (Deutsche Forschungsgemeinschaft).

Editors: Harald Bathelt, Johannes Glückler

Managing Editor: Heiner Depner

ISSN: 1612-8974

© 2008 SPACES online. All rights reserved. Short sections of the text, not exceeding two paragraphs, may be quoted without explicit permission provided that full credit is given to the source.

Islands of expertise – global knowledge transfer in a technology service firm

1 Introduction

In today's global business, knowledge-intensive firms face the managerial challenge of making localized knowledge available at other places in order to enhance the reuse of good practices, support innovative practice and prevent the re-invention of the wheel. This is particularly pronounced in businesses that provide expertise services to clients. In contrast to manufacturing firms, where global competitive advantage is primarily found in scale economies from international integration (Porter 1986), expertise service firms are much more limited in their spatial division of labor because they work in close interaction with their clients. Generally, the greater the need for individual expertise and the greater the specificity of services the less scale economies can be gained from global integration (Aharoni 1996).

Consequently, professional service firms need to look for distinct areas of global competitive advantage when compared with the multinational manufacturing enterprise. There are two sources of global competitive advantage (Løwendahl 2000): firms may draw a positive reputation from global presence and utilize that reputation to win new clients in new markets; or they may benefit from global presence by accessing a broader pool of knowledge and professional experience. One of the key synergies to be realized is diverse knowledge accumulation and internal transfer, first to reutilize expertise and second, to transform that expertise into new knowledge. If professional service firms fail to realize the transfer of their inimitable resources, they miss out essential opportunities of global business and global competitive advantage.

This paper argues for a relational understanding of knowledge and adopts a network perspective on the circulation of expertise within multinational service companies (Borgatti and Cross 2003; Bathelt and Glückler 2005). For the purpose of this paper, expertise shall be defined as the cognitive combination of formal knowledge and experience. Often the generation and the transfer of knowledge are treated as different things. While knowledge generation is conceived as a process of innovation, knowledge transfer is referred to as the mere diffusion of existing knowledge (Caspers and Kreis-Hoyer 2004). This distinction, however, underestimates the innovative potential of knowledge transfer since it treats transfer as an issue of identical knowledge replication. Instead, this paper argues that knowledge transfer forms part of the innovation process itself because the exchange of existing expertise potentially feeds into new ideas and solutions: learning is a collective process in which knowledge is shared, articulated and reinterpreted to inspire new ideas (Lawson and Lorenz 1999). As such, the transfer of knowledge becomes a valuable component of the innovation process.

The aim of this paper is to develop and deploy a relational understanding of knowledge and apply it to the empirical context of corporate knowledge transfer by using methods of social network analysis. In particular, this study explores the vulnerability as well as the enabling and constraining conditions of interpersonal and international exchange of expertise between qualified knowledge workers. The next section develops a strategic framing of the analysis in that it conceives a trade-off with respect to generating and sharing nontrivial experiential knowledge across geographically distributed firm units. Section three introduces the specific historical and situation context of a transnational technology consultancy firm that is used as a case example. Section four discusses the concept of know-who and develops the analytical approach to studying knowledge transfer, while section five reports the research methodology. Section presents visual as well as analytical analysis of a complete global corporate knowledge network and will demonstrate the vulnerability of interna-

tional knowledge flows. It will also provide evidence of the marked impact of geographical dispersion leading to organizational knowledge islands.

2 Geographical distribution vs. organizational coherence of knowledge

From a geographical perspective the organizational challenge of transferring expertise between geographically distributed sites is to be framed in a trade-off between knowledge diversity and organizational coherence. The trade-off is conceptualized between two poles: one where a firm concentrates all its resources in just one location, and the other, where a firm's resources are fully scattered across space. The first extreme offers the advantage of *organizational coherence*. When all corporate production and use of knowledge is co-located in the same place, communicative friction is minimized and local externalities are exploited most efficiently within the firm. Economic geography has inquired intensively the dynamics of geographical clustering as a response to collective learning and knowledge sharing between firms (Malmberg and Maskell 2002). Essentially, it is argued that knowledge activities cluster in response to positive local externalities. Geographical proximity as well as institutional characteristics render information networks leaky and yield spillover effects. In review of the literature, knowledge spillover results from co-location (Jaffe et al. 1993); from the size and mobility of the labor pool (Almeida and Kogut 1999); and the magnitude of strategic alliances among firms. Geographical proximity increases the visibility of each firm such that community membership is more important than structural position. Other recent research suggests that agglomeration sustains even without the existence of local externalities whenever knowledge is complex. This is mainly because with increasing complexity knowledge is more difficult to communicate across distance. In short: geographical distance inhibits knowledge transfer and learning (Sorenson 2005). Though geographical proximity is not a sufficient condition for knowledge spillover if actors belong to different epistemic communities (Lissoni 2001), economic geography has been very strong over the last years in analyzing the benefits of geographical clustering for knowledge exchange and innovation between firms. Here it is argued, that if the activities within a firm are concentrated in one location organizational coherence develops best and favors the reuse and transformation of expertise. This clustering, however, has an opportunity cost which results from context redundancy: all knowledge is based on a similar socio-economic context at the expense of diversity. Though smoothly circulating, the concentration of all knowledge in one pool provokes the risk of long-term lock-in and a fading out of innovativeness.

The second alternative offers the opposite advantage of *knowledge diversity*. I would argue that the principle of geographical separation is a source of diversity. When expertise is constantly reused in different contexts, the variance in contextuality renders new knowledge generation more likely. Geographical separation may thus be conducive to innovation. Particularly, the advantages of diversity through geographical knowledge distribution are even more pronounced, when expertise is produced and transformed in client interaction rather than internal laboratory research. In business services, different social, institutional, cognitive and material contexts provide fertile ground for the emergence of distinct solutions. The fact that firms work intensively at localized client sites spreads learning opportunity over different places and makes every project location essentially a learning site for distinct expertise. Though much of the localized expertise may not be applicable in other contexts, some of it may well help to improve problem solving capabilities in other locations. And even if localized expertise does not directly solve problems in other locations it may still be valuable through recombination with other localized expertise to produce new knowledge. Though research is often a planned and goal-directed process, many innovations are the result of unintended research output. Theoretically, even useless knowledge in one context may become useful in another. In the late 1980s, when Pfizer committed their research to the development of a drug for the treatment of angina, what they actually found was the later called Viagra. It failed on curing angina but offered side effects which were conducive to successful commercialization (Chesbrough 2003). However, only few organizations are prepared to process those 'false

negatives' and therefore leave unintended benefits undetected. In contrast to technology development in closed permanent laboratory locations which are capital-intensive and long-term, client driven knowledge services change place by virtue of client location. Projects in business services are far more short-termed and geographically flexible. Hence, an organization that offers specialist expertise to develop customized solutions for specific problems greatly benefits from its ability, first, to make localized knowledge available in other locations, and second, to recombine localized knowledge from different places to accumulate expertise and generate innovation. According to Porter's notion of global markets, knowledge transfer represents one of only a few strategic opportunities to attain global competitive advantage. The downside of the geographical distribution of organizational units, however, is the cost of maintaining an organization-wide comprehension and circulation of knowledge. The opportunity cost of failing to mobilize localized knowledge to other contexts is the lost profit from knowledge re-utilization and recombination.

In summary, the more geographically diverse a knowledge base becomes, the higher the innovation potential but the more costly it is to circulate, reuse and recombine that distributed knowledge. Should an organization become too dispersed it may lose its coherence to interpret and communicate distributed knowledge. In this case the organization would break up into a set of separate knowledge islands. Similar to the exploitation-exploration problem (March 1991) the knowledge firm has to allocate its resources within a mix of geographical distribution and organizational coherence of its knowledge and learning activities. Ideally, for each investment, at a given degree of geographical distribution and a given regime of knowledge circulation, the firm has to decide how an additional investment pays better off: to set up another geographical unit or to enhance inter-unit communication. This paper explores the case of MILECS¹, a knowledge intensive technology consulting firm, which largely depends on the accumulation and reutilization of tacit knowledge and individual expertise to yield competitive advantage. The trade-off between geographical distribution and organizational coherence will be used as a conceptual framework in order to assess the knowledge architecture of MILECS and to explore some contingent conditions for international knowledge transfer. For the purpose of this exploration, MILECS serves as a good case study for two reasons: first, the company displays a strong pattern of geographical dispersion. Roughly two hundred consultants and engineers are distributed across fifteen offices in ten countries across four continents. Second, the company depends on its ability to mobilize existing localized knowledge and reuse in other places to benefit from its internationality. Before analyzing the knowledge network, the next section introduces the particular challenge of this case.

3 The case of MILECS

MILECS was founded as an engineering service firm in the early 1970s and, over the first years, primarily grew on the back of a few international clients who helped them to piggyback into their first international markets. When the company had established, the founder promoted a partnership governance model and began to sell shares to his senior colleagues. After having opened a few European offices during the 1980s, the internationalization process accelerated during the 1990s, when MILECS launched operations in Latin America, India, and the USA together with some minor representative offices. Given the limited size and the extended geographical dispersion of the company, the management of knowledge transfer soon became a key issue. In 1997, MILECS founded a holding company dedicated to collect and redistribute the finance necessary to develop an international organization between the local offices. Every national subsidiary had to pay an annual contribution and to report financial results to the holding company. In turn, the holding company set up international training programs and other forms of corporate communication (e.g. newsletter). The training program soon

¹/. MILECS is a pseudonym for a medium sized German engineering company dedicated to engineering planning and consulting services in strategy and technology.

became a key element of MILECS approach to global quality and knowledge transfer, as one partner illustrated at the time:

„The backbone of our company is a global training system, which is the same for all employees worldwide. These trainings cover all areas of competence in the firm. They bring people together from all offices and help create the networks for tomorrow...” (Senior Partner, Frankfurt 7.8.2001)

In the same annual meeting of 1997, the partners decided to launch a computer-mediated knowledge management system (*KMS*) which soon went online. Additional staff was recruited to operate and support the system which offered a variety of information services: biographical employee data, a project directory with detailed documentation, literature, tools and software, a global newsletter, and chat and email services for the knowledge exchange between the worldwide employees. By 2000, the company had grown up to thirty partners and more than two hundred consultants. When management decisions became ever more ponderous among the many owners, and when the *new economy* hype had reached its climax, the management board decided to sell the company to a publicly traded software company which had massively expanded by merger and acquisition with a market capitalization of over 1.5 billion Euros. Though the founders of the two firms were long acquainted and had repeatedly worked together in projects, the decision was disastrous. Only a few months later, when the new economy bubble had burst, the investor went bankrupt and burnt MILECS' capital reserves entirely.

Somehow in 2003, the MILECS partners managed to redeem their stakes and thus prevented the company from market exit. Struggling for survival, the management had to install a rough cost control regime and cut down all forms of international support of the organization. This intervention had far-reaching consequences. First, the firm cut half the costs, slimmed down the holding structure and relinquished cost, profit and investment autonomy to the international subsidiaries. Second, they froze programs for international knowledge transfer such as international trainings for novices, specialized practice group meetings of leading experts and even softer forms of knowledge exchange as the global newsletter. If at all, trainings and meetings were held nationally. Third, they stopped delegating senior staff to overseas operations thus impeding the transfer of business and management know-how. Fourth, they abandoned the computer-supported knowledge management system by laying off the responsible administrators and by converting the system into a mere project archive. An external assessment of the *KMS* had proven its limited value in terms of knowledge transfer: people did neither like to search the database nor feed it with professional commitment. Instead, the system served as the internal yellow pages to retrieve reference projects and the respective colleague responsible for those projects. In sum, from one day to the other each national subsidiary was treated as an independent business. The legacy of this intervention becomes visible today, as the CEO describes:

„When we managed to buy the company back we were urged to control costs and to cease the support for internal exchange across offices [...] Today we have consolidated financially, but we don't benefit from our internationality“ (partner, Frankfurt 9.6.2005, translated from German).

At the same time, this self-inflicted crisis was aggravated by a generation shift, in which many of the most senior partners were retired and with them many of the established client accounts. In 2005, two years after turnaround, MILECS had consolidated with around 190 employees worldwide and aimed at assessing their competitive position in the marketplace. Acknowledging their unique international presence vis-à-vis their competitors, the CEO found that MILECS did not make any economic use of their internationality. They did neither circulate and re-use their distributed expertise nor did they economize on cross-selling opportunities due to local access to global client accounts in other markets. The CEO affirmed that “we never wanted to be the largest player; we have always been striving for quality and technology leadership”. In order to achieve higher value-added from the internationality, the holding management and the global advisory board decided to re-launch the promotion of international knowledge transfer, an idea long desired by the rest of the com-

pany. The research presented in this paper starts in this particular situation. After having undergone major financial crisis and now having almost consolidated, the company has begun to assess its current state of internationality in order to commit resources to the development of a global integration of knowledge and expertise. This particular context yielded the opportunity for this research to take place and to carry out an organization-wide analysis of its knowledge transfer.

4 Know-who: networks of personal knowledge transfer

Lundvall and Johnson's (1994) fourfold typology of economically relevant knowledge has often been used to discuss the differences between know-what and know-why on the one hand and know-how on the other. While the former two are in principal codifiable, know-how is hard or sometimes impossible to codify. Know-how refers to the tacit knowledge, i.e. to the procedural knowledge of knowing how to use know-what for certain purposes. It both defines and is defined by social context (Gertler and Vinodrai 2005). Given its collective constitution and socially specific meaning one of the key challenges refers to its transfer within an organization (Gertler 2003). The fourth type of knowledge has received only limited attention in current research: Empirically, however, organizational learning is fundamentally a function of the know-who, i.e. the social relationships that people draw upon to retrieve know-how and to enhance their learning process (Borgatti and Cross 2003). Similar to know-how, know-who cannot be traded. By borrowing Arrow's argument Lundvall and Johnson argue that "you cannot buy trust, and if you could buy it, it would be of little value" (1994: 29). Consequently, if one is to analyze the transfer of inimitable, valuable expertise within an organization but across different geographical locations, it is necessary to understand the underlying architecture of interpersonal relations through which that expertise is channeled. In review of the inter-disciplinary knowledge management debate there are at least three common dimensions or sources of barriers to the transfer of knowledge (Argote et al. 2003): these barriers relate to the type of knowledge, to the actors and to the relationships between the actors in a social context:

Knowledge properties. So far, most emphasis has been put on different kinds of knowledge and their suitability for transfer and imitation. Generally, tacit or sticky kinds of knowledge are more costly or prohibitive to transfer (von Hippel 1994; Szulanski and Jensen 2004). Moreover, empirical research suggests that property rights also incur different barriers to transfer. While private knowledge (e.g. patents, licenses) are protected from spillover, public agencies often actively promote the transfer of knowledge (Uzzi and Lancaster 2003; Owen-Smith and Powell 2004). In addition, further research suggests that causal ambiguity, which is essentially an ingredient to the stickiness of knowledge, also hampers knowledge transfer (Lippman and Rumelt 1982; Szulanski 1996; Argote et al. 2003). Overall, the more context-specific, collective, causally ambiguous and experience-dependent the knowledge, more costly is it to transmit that knowledge for its reutilization through other minds in different contexts. The case of MILECS corresponds with the more complex and context-specific kind of people-embodied experiential knowledge and therefore represents an adequate case for the study of interpersonal knowledge transfer.

Properties of the units. Another barrier is found in the characteristics of the units at different levels. At the level of the individual actor, sources of friction in knowledge transfer are often conceived in terms of status, qualification, competencies, motivation, attitudes and the like. The most prominent concept in this regard is absorptive capacity which describes the capability of an organization or its individuals to identify, incorporate and commercialize new knowledge (Zahra and George 2002). At the empirical level of the firm, it is often measured as the proportion of R&D expenditures in overall revenues (Cohen and Levinthal 1990; Tsai 2001), the same measure that is also often used to assess organizational innovativeness. Hence, there is a risk of tautological association between absorptive capacity and innovation if the same measure is used for both observations. Therefore, alternative proxies have been defined, as for instance, the participation of firms in

academic publications (Cockburn and Henderson 1998) as a measure of an organizational inclination toward external knowledge pools. Another measure used is the similarity of organizational design and the knowledge base between two firms (Lane and Lubatkin 1998). A relational perspective on the know-who within a distributed organization offers another way of conceiving absorptive capacity.

Properties of the relationships between units. Turning the notion of absorptive capacity into a relational concept points to the third source of transfer barrier: the quality and structure of relationships. Empirically, the observed structure of communication mostly diverts from the formally designed organization chart (Krackhardt and Hanson 1993). People share different kinds of dyadic relations between them. Some may be 'arduous and barren' while others are 'intimate and fertile', to use Szulanski and colleagues' terminology (Szulanski 1996; Szulanski and Jensen 2004). Apart from the quality of individual relations, the structure of the overall set of relations in and between organizational units also affects the ease of knowledge transfer. Here, absorptive capacity is a function of the communication structure within the firm. Closed and redundant communication structures tend to reiterate existing knowledge at the expense of absorbing external knowledge (Grabher 1993; Bathelt et al. 2004). At the other extreme, completely open and non-coherent networks are as deficient as closed ones since they cannot process and collectively transform new knowledge into innovative products. Every organization thus has to find a specific mode of organizational communication that ensures coherent internal knowledge development and exchange as well as sufficient interface with the environment, be it intra-firm or inter-firm.

Since network relations require resources to be maintained, inter-unit relations are costly and only beneficial if projects are to fulfill tasks that require tacit knowledge, i.e. if there is a transfer problem (Hansen 1999). In what follows, this paper ventures into the micro-world of personal knowledge transfer in globally distributed workplaces. In the context of MILECS two motivations drive this research: one is to visualize the knowledge 'architecture' (Amin and Cohendet 2004) of the company as represented by the personal exchange relations of its employees and to find ways to assess its degree of integration and vulnerability. The other goal is to explore contingent conditions that hamper and enhance inter-office and international knowledge transfer in line with the mentioned dimensions of knowledge transfer: properties of knowledge, the units, and the relationships between the units.

5 Method

5.1 Network survey and data

One of the crucial motivations for the analysis of the knowledge flow in an organization was to study generic social relationships rather than more artefactual data, as for instance, email log files. Therefore this research had to adopt a survey methodology to generate its own data on the existence of pair wise knowledge exchange. Contact with MILECS had already been established in 2001 such that the company management agreed to take part in the study and provided full support. The survey was carried out in autumn 2005 with a response of 129 employees which corresponds with a response rate of 69%. Most of the missing 58 individuals were support staff or novices in their first year with the company. By agreement with the company management they were not invited to complete the questionnaire. Under conditions of imperfect data, it has been shown that the correlation between real and observed measures of most centrality measures converges to 1 with increasing size of the sample. When the sample covers 70% or more of the population, the correlation coefficients for almost all measures are 0.8 or higher (Costenbader and Valente 2003). Overall, network measures of centrality are relatively robust against random network disruptions and imperfect data (Borgatti et al. 2006). In order to compare networks of the same members but across different relations, the multiple regression quadra-

tic assignment procedure (MRQAP) is an appropriate technique. It uses random matrix permutations to generate a reference distribution against which the correlation coefficients of the observed matrices are compared (for details of the procedure cf. Krackhardt 1987; Kilduff and Krackhardt 1994; Snijders and Borgatti 1999).

5.2 Variables

Following a relational perspective on knowledge transfer, all variables are operated as relations between actors. The analytical approach used here is to assess transfer barriers at the level of the individual as a result of the relationship between each pair of employees. The dependent variable is the personal *knowledge exchange* relation between all pairs of employees within the company. This research had taken particular care for the distinction of information transfer and the transfer of know-how. In the context of the empirical research, however, the employees themselves did not make significant distinctions between these concepts for themselves². Both variables were correlated at an $r = 0.88$. The analyses presented here are based on the information transfer network.

Table 1: Variable labels and definitions, dyad level

Label	description
Dependent variables	
Knowledge transfer	Dummy, 1 = two employees maintain important knowledge exchange
Independent variables	
A. Geography	
Co-location	Dummy, 1 = two employees are based at the same office
B. Hierarchical status	
Status equality	Dummy, 1 = two employees share the same hierarchical level
status level	Product of the ranks of two employees (range 1 to 25)
C. Area of expertise	
Competence overlap	Number of same areas of expertise between two employees (range 0 to 8)
Qualification equality	Dummy, 1 = two employees share the same professional qualification
D. Seniority	
Age difference	Difference in years of age between two employees (0 to 47)
Tenure difference	Difference in years of employment between two employees (0 to 29)
E. Language	
Native language equality	Dummy, 1 = two employees share the same mother tongue
Language overlap	Number of languages that two employees jointly speak (range 0 to 4)

The independent variables include attribute based dyadic relations as the unit of observation. These variables are obtained by converting individual attributes over a number of actors into relational information between these actors, e.g. as expressions of similarity or dissimilarity between actors with respect to a particular characteristic (Borgatti and Everett 1997). In this manner, all variables are treated as expressions of the relationship between the units rather than their attributes. Five sets of variables are used (see Table 1): *Geography*. For each pair of employees this variable is one if two if two employees work in the same permanent office and

²/. The calculation of the E-I-Index requires symmetrical data and does not distinguish the values of edges. The two questions were formulated in the following way: (1) "Information - How important is this person for you to learn about news, events and work-related information? Note: information is different from knowledge and advice. Please concentrate only on the person's contribution to your information provision and not on their impact on your learning effects and expertise generation". (2) "Know-how - How effective has this person been in giving you professional advice and in thinking through challenging problems at work? Note: Please concentrate on the person's contribution to the development of your professional skills, experience and expertise by giving advice or collaborating with you (and not on the transmission of mere information only)".

zero if they work in different offices. The second construct is *hierarchical status*. The company distinguishes five hierarchical levels of job position, i.e. support, consultant, senior consultant, principle and director. Based on these numbered categories, two distinct measures are calculated: (i) *Status equality* is a binary variable which is 1 if two people have the same position and zero if not. (ii) *Status level* multiplies the ranks of each of both employees to express both elements, similarity and level of the pair of employees in the firm. The third construct is the *area of expertise* which is measured by two variables: (i) the notion of *competence overlap* assess the degree of overlap between different actors according to their joint competences, as for example, Hansen did at the level of projects (Hansen 2002). In the case of MILECS there is a clearly defined matrix of eight areas of expertise in which every professional locates his expertise. In many cases individual employees overlap with a number of different competence fields such that the measure counts the number of joint areas of expertise for each pair of coworkers. (ii) *qualification equality* is a binary variable that looks at the expertise gained prior to the work in the company and is one if two employees took their degrees in the same subject. The fourth set of variables relates to *seniority*. According to the community of practice literature, new members know less and therefore are more likely to seek information than others (Borgatti and Cross 2003, 438). This concept is measured by (i) age difference in years between any two employees, and (ii) the difference in years of tenure with the firm. The fifth set of variables is *language* which is measured by two variables. (i) *Native language equality* is a binary which is one if two employees have the same native language. (ii) *Language overlap* is a more encompassing variable that compares each pair of employee and counts the overlap of languages that they jointly speak with fluent command.

6 Results

6.1 Exploring the MILECS knowledge network

The network has one main component of 123 employees and 6 further isolated individuals who are disconnected to the network. Within the main component there is an average path length between any two employees of 3.1 steps. The longest geodesic is 7, that is, there are nine relations with a longest shortest path of six intermediate contacts between them. 10 percent of pairs of employees are only mutually connected at a path length of 5 (that is, there at least four intermediaries between them). Apart from the obvious density of interpersonal exchange within local offices, there are numerous personal knowledge linkages that were qualified as important sources of advice and expertise. Overall, every office is linked to at least two other offices in the corporate network. The linkage is most intensively realized between the two German offices, where intra-office and inter-office linkages seem equally developed (Figure 1). Extracting these two offices from the network, it would look just a perfect picture of a network suited to customized response conditions (Cross et al. 2005). Compared to Frankfurt and Berlin, however, the other offices clearly fall behind the level of inter-office exchange and are much more focused on local knowledge circulation.

How vulnerable is the knowledge network of MILECS? Among the several structural problems that Krackhardt and Hanson (1993) identify in specific networks, three are particularly interesting in this context: Networks may suffer from *imploded relationships* as the result of communication being locked-in solely within a department or from a *fragile structure* where a highly coherent group maintains only one strong external communication with one other group instead of many; networks may also suffer from *bow ties* where many employees depend on one single person but not on each other and where that one person concentrates control over the communication flow. Using these concepts for a first graphical assessment, some of the problems become visible. Offices in Mexico, Argentina, Chile and India are rich in local interconnection but rather weak in international knowledge transfer. Their international linkages mostly concentrate on one or a few *bow ties* in the sense defined by Krackhardt and Hanson (1993).

Abbildung 1: *The knowledge transfer network of MILECS*

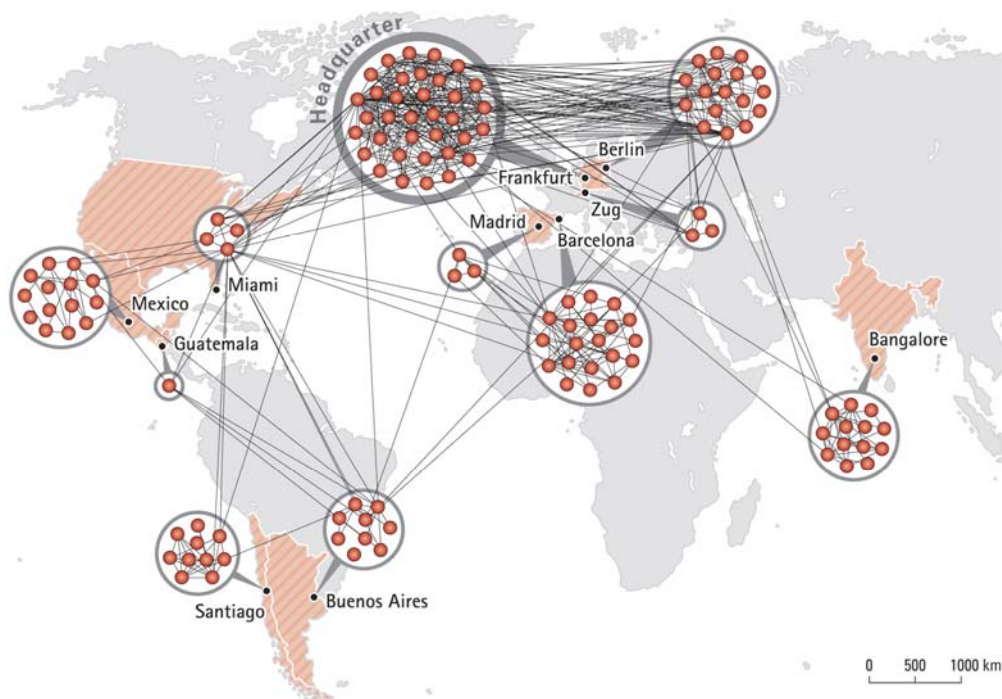
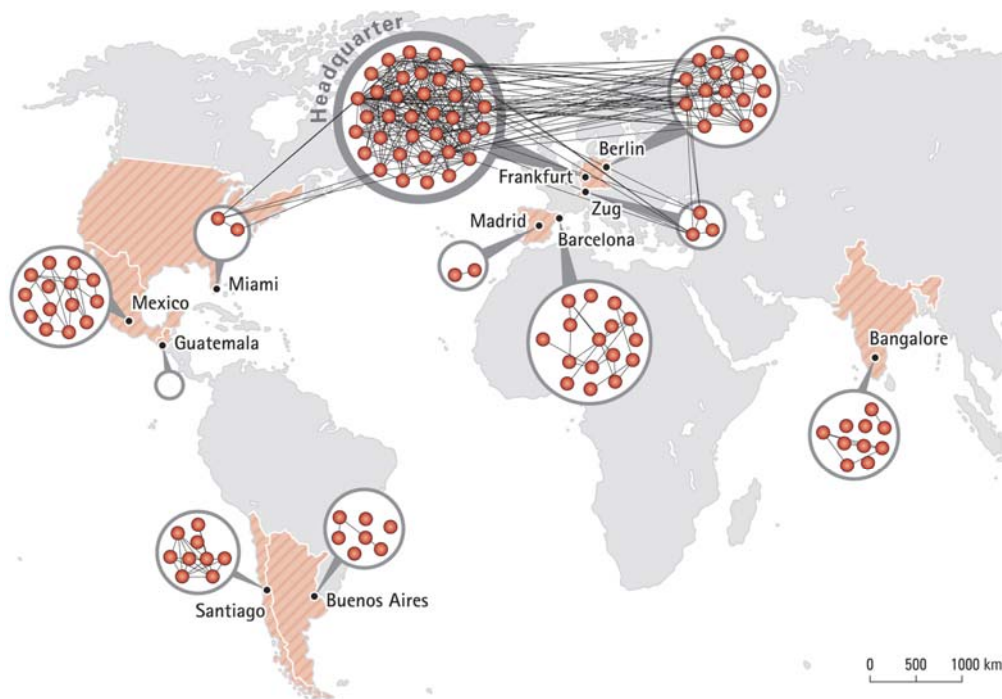


Abbildung 2: *The knowledge network of MILECS without 15 key individuals*



So what makes this company different from a set of independent, nationally operating firms? The answer is: fifteen people. If the most important boundary spanners are removed one after another, the international knowledge architecture of MILECS breaks apart in eight separate knowledge islands (Figure 2). It is interesting to note that the knowledge transfer between the four German speaking offices in Germany, Switzerland and the US cannot be separated even by omitting the most influential employees. Here, inter-office transfer seems to have developed in far more robust way than in the predominantly Spanish speaking offices. Describing and looking at the visual representation of network tells something about the vulnerability and overall design of international knowledge transfer. The next section, however, uses methods of social network analysis to answer more detailed questions about the barriers and drivers of inter-office knowledge exchange at MILECS.

6.2 Barriers to geographical knowledge transfer

The first set of analyses uses the MRQAP technique to test the effect of geography, status, area of expertise, seniority and language on the inter-personal knowledge transfer (Table 2). While models 1 to 4 display the bivariate statistics, model 5 represents a multivariate regression. The regression models suggest the following results: Co-location has the strongest effect on knowledge transfer. Though of little surprise, the single most important variable for knowledge transfer is the locational split of the organization (Table 2). Whenever two employees work in the same office, they are more likely to establish and maintain personal knowledge exchange. On the one hand, this is a strategically planned result because people are co-located in organizational units exactly because they shall work together. On the other hand, this finding reproduces the concern that the sharing of geographically distributed expertise is a difficult managerial task. Co-location explains around 17% of variation in the distribution of knowledge transfer relations.

Tabelle 2: MRQAP regression models, dependent variable: information

	Model 1	Model 2	Model 3	Model 4	Model 5
Variables					
Intercept	.018**	.004**	.013**	-.045	-.063
Co-location	.277**			.260**	.261**
Status level		.007**		.007**	.007**
Status equality					.027**
Native language equality			.119**	.027**	.026**
Language overlap					.004
Tenure difference					-.002
Age difference					.003
Competence overlap					.006
Qualification equality					-.004
Statistics					
Adjusted R^2	.172	.027	.061	.204	.215
(p)	.0001	.0001	.0001	.0001	.0001

* $p < 0.01$, ** $p < 0.001$; 16,512 observations; 2,000 permutations

The second important condition is status similarity between employees. There are several effects with respect to status. Generally, if two employees have the same position they are more likely to exchange their knowledge. Though often people with the same ranks do not work on the same projects they significantly engage in knowledge transfer. In contrast, the stronger the difference in position between two employees less they engage in knowledge transfer. Moreover, there is a second effect of hierarchy. The higher ranked a pair of employees is, the more it engages in knowledge transfer. The measure here is the product of rank values for each pair of actors in the company. In short: directors engage more in knowledge exchange than consultants and

other employees in lower positions. A third expectation about knowledge transfer in an organization is related to seniority. Generally, one would expect that an expert's age and seniority make a difference for the way she gets involved in knowledge transfer. According to the community of practice literature, new members know less and therefore are more likely to seek information than others (Borgatti and Cross 2003, 438). In the case of MILECS, however, neither employee age nor her seniority, i.e. the number of years of employment with MILECS, have any affect on the structure of knowledge transfer. A fourth variable affecting international knowledge transfer is language. The effects here are quite interesting. While the constraint of native language on communication is rather intuitive and significant, the general language overlap between people draws a different picture. If two people speak the same native tongue they are more likely to exchange expertise. If, however, two people have fluent command of at least one joint language, this does have no measurable affect on their propensity to exchange their knowledge. In other words: Although employees are able to communicate in a language of mutually fluent command, this does not improve the overall knowledge exchange. In this respect, language is obviously not the problem of knowledge transfer.

The fifth set of conditions relates to the area of expertise. Generally one would assume that people working in same areas of expertise maintain a more pronounced exchange of expertise. However, there is only weak evidence for this expectation. It is interesting to see that the same qualification does not affect the communication network, while the sameness in firm-specific competences does. On the one hand, educational and professional background has no effect at all on knowledge transfer. Whether two employees share the same or similar qualifications or not has no influence upon their choice to exchange knowledge with each other. On the other hand, competence overlap between two employees has a significant albeit weak effect on knowledge transfer. MILECS has a clear definition of areas of expertise which are organized in a competence matrix. Every employee is dedicated to one or more of these areas and may therefore overlap with other colleagues in the company. However, this effect is negligible and explains far less than a percentage of the variance in the data.

In summary, a combined model 5 of the impact of all five constructs produces a highly significant though moderate explanation of the variance in distribution of knowledge transfer relations. Interpersonal knowledge transfer within the organization is constrained by location and increases with status level and equality of a pair of employees. While these effects may not be much of a surprise, it is less intuitive to observe that seniority, age, qualification and educational background as well as language skills are not related to personal knowledge transfer relations.

6.3 Boundary spanners in international knowledge transfer

After having assessed some major constraints on the formation of knowledge transfer relations, a final step in the analysis asks which kind of management intervention may be appropriate to enhance inter-office knowledge transfer. The extent to which an employee is involved in inter-office knowledge exchange is expressed by her E-I-value (Krackhardt and Stern 1988), i.e. the relative commitment of her entire personal relations to people outside the own office. The E-I Index, here, calculates the proportion of a person's relationships with members of other groups (*here*: offices) by subtracting the number of internal ties (within the same office) from the number of external ties (other offices) and divides this difference by the sum of all ties³. MILECS supports a number of programs to enforce international knowledge transfer. This includes global training courses, temporary deployment of professionals to an office abroad and the assignment to an international project

$$E - I \text{ Index} = \frac{EL - IL}{EL + IL}$$

³ The E-I-Index is calculated as follows: $\frac{EL - IL}{EL + IL}$, where *EL* are external linkages and *IL* are internal linkages.

with occasional stays in other offices. The effectiveness of the programs on inter-office knowledge transfer is tested by means of simple OLS regression models (Table 4). In the bi-variate regression, all three forms of international encounter are conducive to an individual's future inclination to maintain inter-office knowledge transfer. By far the most effective tool to enforce long-term knowledge transfer between geographically separated experts is to assign employees to foreign offices for a period of time (*expatriation*). International office deployment explains 10 percent of an individual's E-I-value in the knowledge transfer structure. Finally, the mix of measures seems to be most effective (*program diversity*). Individuals who had experienced office deployment, international project work and global trainings were more likely to have pronounced international involvement in knowledge transfer than other employees. The diversity of international experiences accounts for 12.5 percent of overall variance in the dependent variable.

Table 3: OLS unstandardized regression coefficients for predicting knowledge transfer across offices (individual E-I-Index of each employee)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Variables						
Intercept	-.665***	-.633***	-.657***	-.833***	-.191***	-.552***
Expatriation	.387***					.218*
Projects		.002***				.000
Trainings			.0189***			-.000
Program diversity				.157***		.085*
Local focus					-.099**	-0.061
Statistics						
R ²	.118	.068	.063	.137	.041	.189
Adjusted R ²	.104	.053	.049	.124	.026	.150
(p)	.000	.002	.007	.000	.024	.029

* p < 0.1, ** p < 0.05, ***p < 0.01; 129 observations

Independent variables: *Expatriation*. Dummy, 1 = assignment to another office for a minimum of 2 months; *Projects*. Dummy, 1 = assignment to international projects involving the collaboration with staff from other offices; *Training*. Number of global trainings an employee has taken part in; *Program diversity*. Sum of the binary variables training, expatriation, project (range 0 to); *Local focus*. Average score on a set of confirmations about the degree of satisfaction about the availability and quality of knowledge in the own office (range 0 to 6).

7 Discussion and Conclusion

This paper has used a single firm case study to explore the structural foundations of international intra-firm knowledge transfer in an industry of knowledge intensive expert technology services. The case of MILECS has been particularly interesting because the medium sized company is characterized by a pronounced geographical dispersion across four continents and by a severe prior corporate crisis, which had forced its management to cease all support for the international administration and knowledge management. In a situation where MILECS had been recovering and thinking about measures to realize advantage from its global presence, this research had started to provide a diagnosis of its current knowledge architecture. By surveying the entire organization and using methods of social network analysis, the case study has produced insight into the structural aspects of a corporate knowledge transfer network.

First, using visual analysis the knowledge network was found to be relatively vulnerable as a consequence of many bow ties between offices. Inter-office communication was channeled and mediated by only a handful of key boundary spanners. The difference between a global company and a set of nationally separated knowledge islands was only fifteen individuals. Second, personal knowledge transfer between every pair of employees was found to be constrained mainly by geographical co-location, native language and the similarity and level of hierarchical status. Knowledge transfer was independent of age, company tenure, qualification and the overlap

of language skills. Third, it was found that international knowledge transfer can be enforced and intensified by expatriation programs. Employees that were deployed to other offices for longer periods of time (usually between several months and two years) or had taken part in diverse programs with international contact, clearly contributed to the international knowledge transfer and displayed a stronger international orientation of their communication. Apart from their immediate effect, these measures produce positive long-term effects for the sustained international knowledge transfer.

Finally, the trade-off between organizational coherence and knowledge diversity through geographical separation builds a framework for metering the commitment to corporate knowledge management. This framework balances the value of knowledge circulation against the value of continuous global expansion and thus puts emphasis on effective internal knowledge architectures in transnational firms. A knowledge architecture based on bottleneck effects between unconnected knowledge pools is more likely to convey private returns to the boundary spanners and substantial losses through unrealized knowledge reuse than collective returns to the organization as a whole. Organizations that depend on client interaction in order to generate new knowledge are bound to geographically dispersed learning and should therefore commit substantial intelligence and resources to the effective circulation of expertise within their particular organizational geographies.

References

- Aharoni, Y. (1996) The organization of global service MNE's. *International Studies of Management and Organization*, 26: 6-23.
- Almeida, P., Kogut, B. (1999) Localization of knowledge and the mobility of engineers in regional networks. *Management Science*, 45: 905-17.
- Amin, A., Cohendet, P. (2004) *Architectures of Knowledge: Firms, Capabilities, and Communities*. Oxford, New York: Oxford University Press.
- Argote, L., McEvily, B., Reagans, R. (2003) Managing knowledge in organizations: An integrative framework and review of emerging themes. *Management Science*, 49: 571-82.
- Bathelt, H., Glückler, J. (2005) Resources in economic geography: from substantive concepts towards a relational perspective. *Environment and Planning A*, 37: 1545 – 63.
- Bathelt, H., Malmberg, A., Maskell, P. (2004) Clusters and knowledge: Local buzz, global pipelines and the process of knowledge creation. *Progress in Human Geography*, 28: 31-56.
- Borgatti, S. P., Carley, K. M., Krackhardt, D. (2006) On the robustness of centrality measures under conditions of imperfect data. *Social Networks*, 28: 124-36.
- Borgatti, S. P., Cross, R. (2003) A relational view of information seeking and learning in social networks. *Management Science*, 49: 432-45.
- Borgatti, S. P., Everett, M. G. (1997) Network analysis of 2-mode data. *Social Networks*, 19: 243-69.
- Caspers, R., Kreis-Hoyer, P. (2004) Konzeptionelle Grundlagen der Produktion, Verbreitung und Nutzung von Wissen in Wirtschaft und Gesellschaft. In R. Caspers, N. Bickhoff, T. Bieger (eds) *Interorganisatorische Wissensnetzwerke. Mit Kooperation zum Erfolg*. Berlin, Heidelberg: Springer, 17-58.

- Chesbrough, H. (2003) Managing your false negatives. *Harvard Management Update* 8: 3-4.
- Cockburn, I. M., Henderson, R. M. (1998) Absorptive capacity, coauthoring behavior, and the organization of research in drug discovery. *Journal of Industrial Economics*, 46: 157-82.
- Cohen, W. M., Levinthal, D. A. (1990) Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*, 35: 128-52.
- Costenbader, E., Valente, T. (2003) The stability of centrality measures when networks are sampled. *Social Networks*, 25: 283-307.
- Cross, R., Liedtka, J., Weiss, L. (2005) A practical guide to social networks. *Harvard Business Review* 124-32.
- Gertler, M., Vinodrai, T. (2005) Learning from America? Knowledge flows and industrial practices of German firms in North America. *Economic Geography*, 81: 31-52.
- Gertler, M. S. (2003) Tacit knowledge and the economic geography of context, or the undefinable tacitness of being (there). *Journal of Economic Geography*, 3: 75-99.
- Grabher, G. (1993) The weakness of strong ties: The lock-in of regional development in the Ruhr area. In G. Grabher (ed.) *The embedded firm: On the socioeconomics of industrial networks*. London: Routledge, 255-77.
- Hansen, M. T. (1999) The search-transfer problem: the role of weak ties in sharing knowledge across organizations subunits. *Administrative Science Quarterly*, 44: 82-111.
- Hansen, M. T. (2002) Knowledge networks: explaining effective knowledge sharing in multiunit companies. *Organization Science*, 13: 232-48.
- Jaffe, A. B., Trajtenberg, M., Henderson, R. (1993) Geographic localization of knowledge spillovers as evidenced by patent citations. *Quarterly Journal of Economics*, 108: 577-98.
- Kilduff, M., Krackhardt, D. (1994) Bringing the individual back in: a structural analysis of the internal market for reputation in organizations. *Academy of Management Journal*, 37: 87-108.
- Krackhardt, D. (1987) QAP partialling as a test of spuriousness. *Social Networks*, 9: 171-86.
- Krackhardt, D., Hanson, J. (1993) Informal networks: The company behind the chart. *Harvard Business Review*, 71: 104-11.
- Krackhardt, D., Stern, R. N. (1988) Informal networks and organizational crises: an experimental simulation. *Social Psychology Quarterly*, 51: 123-40.
- Lane, P. J., Lubatkin, M. (1998) Relative absorptive capacity and interorganizational learning. *Strategic Management Journal*, 19: 461-77.
- Lawson, C., Lorenz, E. (1999) Collective learning, tacit knowledge and regional innovative capacity. *Regional Studies*, 33: 305-17.
- Lippman, S. A., Rumelt, R. P. (1982) Uncertain imitability: An analysis of interfirm differences in efficiency under competition. *The Bell Journal of Economics*, 13: 418-38.

- Lissoni, F. (2001) Knowledge codification and the geography of innovation: the case of Brescia mechanical cluster. *Research Policy*, 30: 1479-500.
- Løwendahl, B. (2000) The globalization of professional business service firms. Fad or genuine source of competitive advantage. In Y. Aharoni, L. Nachum (eds) *Globalization of Services. Some Implications for Theory and Practice*. London, New York: Routledge, 125-41.
- Lundvall, B.-Å., Johnson, B. (1994) The learning economy. *Journal of Industry Studies*, 1: 23-42.
- Malmberg, A., Maskell, P. (2002) The elusive concept of localization economies: Towards a knowledge-based theory of spatial clustering. *Environment and Planning A*, 34: 429-49.
- March, J. G. (1991) Exploration and exploitation in organizational learning. *Organization Science*, 2: 71-87.
- Owen-Smith, J., Powell, W. W. (2004) Knowledge networks as channels and conduits: The effects of spillovers in the Boston biotechnology community. *Organization Science*, 15: 5-21.
- Porter, M. (1986) Competition in global industries: a conceptual framework. In M. Porter (ed.) *Competition in Global Industries*. Cambridge, Ma: Harvard Business School Press, 15-60.
- Snijders, T. A., Borgatti, S. P. (1999) Non-parametric standard errors and tests for network statistics. *Connections*, 22: 61-70.
- Sorenson, O. (2005) Social networks, informational complexity and industrial geography. In D. B. Audretsch, D. Fornahl, C. Zellner (eds) *The Role of Labour Mobility and Informal Networks for Knowledge Transfer*. New York: Springer, 79-95.
- Szulanski, G. (1996) Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic Management Journal*, 17: 27-43.
- Szulanski, G., Jensen, R. J. (2004) Overcoming stickiness: An empirical investigation of the role of the template in the replication of organizational routines. *Managerial and Decision Economics*, 25: 347-63.
- Tsai, W. (2001) Knowledge transfer in intra-organizational networks: Effects of network position and absorptive capacity on business unit innovation and performance. *Academy of Management Journal*, 44: 996-1004.
- Uzzi, B., Lancaster, R. (2003) Relational embeddedness and learning: The case of bank loan managers and their clients. *Management Science*, 49: 383-99.
- von Hippel, E. (1994) 'Sticky information' and the locus of problem solving: Implications for innovation. *Management Science*, 40: 429-39.
- Zahra, S. A., George, G. (2002) Absorptive capacity: A review, reconceptualization, and extension. *Academy of Management Review*, 27: 185-203.