LABOUR MOBILITY AND INFORMAL CONTACTS AS MECHANISMS OF KNOWLEDGE DIFFUSION

Erik Lundmark* & Magnus Klofsten
HELIX Excellence Centre & Department of Management and Engineering,
Linköping University

*Corresponding author at: Linköping University (IEI), SE-581 83, Linköping, Sweden.
Telephone: +4613284431, E-mail: erik.lundmark@liu.se

Abstract
This article is positioned in the debate regarding the relative importance of labour mobility and informal contacts as mechanisms for knowledge diffusion between organisations. Empirically, the article assesses the importance of different knowledge sources utilised by 219 participants in two high-tech, R&D driven, non-incremental, product development projects in large corporations, located in local labour markets highly specialised in their respective industry clusters. The results show that the most important knowledge sources for the respondents are colleagues within the organisation. Informal contacts outside the organisation, although prevalent, are rather unimportant as knowledge sources. External contacts are related to creative contributions in the projects regardless of whether the contributions are self-assessed or peer assessed. However, the support for informal contacts in particular, being related to creative contributions in the projects, is rather weak. Implications for the understanding of knowledge diffusion are discussed and directions for future research suggested.

1. Introduction
Krugman's (1991a) model, attributing agglomeration of manufacturing to economies of scale and lower transportation costs, have been followed by an increasing interest in knowledge spillovers as drivers of agglomeration of innovative (e.g. Kim et al., 2006; Almeida & Kogut, 1999; Saxenian, 1994) and entrepreneurial activity (Acs et al., 2008).

At a macro-level of analysis, the academic debate has been concerned with the extent to which specialisation (Marshall, 1890/1920; Arrow, 1962; Romer, 1986) and diversity (Jacobs, 1969; Glaeser et al., 1992) of organisations within a geographical area are associated with knowledge spillovers, innovation and growth. The empirical results are mixed and depend on e.g. the levels of industrial and geographical aggregation (Beaudry & Schiffauerova, 2009).

Defying Carter's (1989) statement that information exchange "*leaves no paper trail to inform research*"(p 162)[1], many studies have been directed at patent citation patterns (e.g. Jaffe, Trajtenberg & Henderson, 1993; Almeida & Kogut, 1999). However, these approaches have been criticised for failing to prove the claimed importance of knowledge spillovers in agglomeration of innovative activity (c.f. Breschi & Lissoni, 2001a). Furthermore, Breschi & Lissoni (2001a) expressed concerns that the term knowledge spillover often is used carelessly for any kind of knowledge flow, even those that are not externalities. In order to move our understanding of knowledge spillovers forward, Breschi and Lissoni (2001b) called for more research on how knowledge is actually transmitted and among whom.

Consequently, at a meso- and micro-level, the academic debate has focused on the relative importance of the mechanisms by which knowledge and ideas diffuse between existing organisations and from existing organisations to new business start-ups.

This article is positioned in the debate regarding the relative importance of labour mobility and informal contacts as mechanisms of knowledge diffusion in innovative and entrepreneurial processes. Labour mobility refers here to employees changing employers and informal contacts refer to contacts on an unofficial basis with people outside the employing organisation.

This debate has been particularly salient in relation to regional development, where e.g. Power & Lundmark (2004, p. 1027) argued that labour mobility is the main source of knowledge transfer as opposed to informal contacts between firms:

> *"Thus rather than focusing on diffuse and vague notions that knowledge and innovation reside in the 'Bohemian' nature (Florida, 2002), 'in the air' (Marshall, 1920) or in the 'buzz' (Storper and Venables, 2002) of urban life, we believe [...] that knowledge and innovation most commonly develop through interaction located in the workplace itself."*

On the other hand we have Dahl & Pedersen (2004, p. 1685) who argued that:

> *"informal contacts are potentially an important source of knowledge for the engineers in their daily working lives. Even specific knowledge about new products, which is likely to be very firm-specific and which the firms are likely to want to protect from competitors, is shared among these engineers."*

These phenomena, i.e. mobility between employers and informal contacts between organisations, are not independent mechanisms but related in the sense that informal contacts are often kept between former colleagues even after one or both have changed employer (c.f. Zellner & Fornahl 2002). Consequently, it is argued that labour mobility is potentially a more potent mechanism for knowledge diffusion in large labour markets where job changers are likely to stay within the same region and thus more likely to keep informal contacts with former employers and colleagues (e.g. Power & Lundmark 2004).

The importance of studying these mechanisms has been stressed by many scholars (e.g. Fornahl et al., 2005; Pennings & Wezel, 2007). Dahl & Pedersen (2004) specifically called for research comparing the importance of informal contacts as a source of knowledge to other sources e.g. colleagues within the organisation, internet and technical journals. In this study we heed this call.

Empirically, this study focuses on knowledge sources utilised by employees in innovative high-tech projects in large corporations. More specifically, we assess the relation between utilised knowledge sources and self-perceived as well as peer-perceived contributions by employees in these projects. The corporations are located in highly specialised local labour markets, identified as local clusters by Lindqvist et al. (2002). We describe the specific setting of the projects because contextual factors influence the extent to which different knowledge sources are used (c.f. Ibrahim et al., 2009). However, this study is not specifically focused on cluster phenomena.

The article is structured as follows: In the next section we review the literature on individual learning in an organisational context and propose our hypotheses. In section 3 we present the empirical setting and our methodology. In section 4 we present the results and lastly, in section 5, we discuss our findings and propose directions for future research.

2. Types of knowledge & diffusion mechanisms

Learning in an organisational context has been studied at various levels of analysis, from the individual level through groups and organisations to inter-organisational learning, e.g. clusters, innovation systems and partnerships (c.f. Ellström, 2010). In this article, we study knowledge sources utilised by individual participants in high-tech product development projects. Consequently, the literature review primarily focuses on knowledge frameworks applicable at an individual level of analysis.

In typologies of knowledge, a common distinction is between what is tacit and what is explicit[2] (c.f. Polanyi, 1966). The alleged "tacitness" of scientific and technical knowledge implies that this knowledge is transferred between people mainly through face-to-face interaction. This feature is frequently suggested as a factor that contributes to agglomeration of innovative activity (See Breschi & Lissoni 2001a; b for a critical review).

However, some tacit knowledge can be externalised, i.e. converted to explicit knowledge in the form of e.g. written documents (Nonaka & Toyama, 2003). This type of explicit knowledge can be transferred over long distances. Particularly, this process has been facilitated by information and communication technology (ICT) (Audretsch & Keilbach, 2005). In order for an agent to successfully utilise explicit knowledge, two processes remain: firstly, the combination of sources of explicit knowledge, i.e. the gathering and integration of explicit knowledge sources; secondly, the internalisation of the explicit sources through experimentation and reflection (Nonaka & Toyama, 2003). These processes draw heavily on the tacit knowledge of the learner; therefore, "all knowledge is either tacit or rooted in tacit knowledge" (Polanyi, 1966 p 7). These processes are rarely, if ever, leading to perfect transfer of practices between organisations. In fact, much of the early diffusion literature has been criticised for not paying due attention to the imperfect translations that are associated with the diffusion of practices (c.f. Rogers 2003).

Recent literature underlined that the readiness to adapt practices to local conditions is vital to successful transfer of practices between organisations (c.f. Klofsten et al. 2009). Other factors that have been found important to transfer patterns are the complexity of the knowledge and the social proximity of the sender and the receiver (Sorenson et al., 2006). Sorenson et al. (2006) find that knowledge of intermediate complexity spreads more easily between people who are socially close than between more socially distant people. Knowledge high in complexity hardly diffuses at all and knowledge low in complexity diffuses easily both between people who are socially close and between people who are more distant (Ibid).

In describing knowledge transfer, Sorenson et al. (2006) used the metaphor of a recipe, which contains many implicit steps (e.g. a recipe usually does not describe how to boil water or chop vegetables). Consequently, a reader must share a frame of reference with the originator to be able to successfully use the recipe. Breschi and Lissoni (2001b) argued that scientists and engineers often belong to what they referred to as epistemic communities, in which a basic frame of reference exists. Therefore, knowledge that would be perceived as highly complex

by anyone outside the epistemic community can relatively easily be externalised and shared within the community. Consequently, having scientists and engineers who belong to relevant epistemic communities, is vital to a firm's absorptive capacity, i.e. the ability to absorb external knowledge (c.f. Cohen & Levinthal, 1990).

Barriers to knowledge flows are not only found between but also within organisations (c.f. Ensign & Hébert, 2010). Szulanski (1996) found that the absorptive capacity of the recipient, the nature of the knowledge and the nature of the relationship between source and recipient are the most important factors affecting knowledge transfer within firms. Although firms can spend resources on facilitating internal knowledge transfer, e.g. by codifying knowledge, this is a double-edged sword since "*capabilities which can be easily communicated within the firm are more likely to be easily imitated by competitors.*" Zander & Kogut (1995, p. 76).

Zellner & Fornahl (2002) go beyond the tacit explicit dichotomy and create a typology of six types of scientific knowledge. (1) Broad, general knowledge and familiarity with the scientific discipline (BKG – in practice only transferable through hiring). (2) Substantive knowledge about scientific facts and theories (SFK), i.e. high-end knowledge, embodied in scientific publications and patents (can be transferred through hiring as well as formal and informal contacts). (3) Specialised methodological knowledge of techniques, experimental methods and testing procedures (SPK) (in practice only transferable through hiring). (4) Knowledge of specialised instrumentation and laboratory equipment (INS – can be transferred through hiring as well as formal and informal contacts). (5) Non-subject specific analytical skills (NSA - Only transferable through hiring). (6) Data analysis and processing skills (DPS - only transferable through hiring). Accordingly, all of their six categories can be transferred through labour mobility, but only a limited subset can, in practice, be transferred through formal or informal contacts between people inside and outside the organisation.

2.1. Informal contacts

Dahl & Pedersen (2004), surveying employees in firms in the NorCOM cluster in northern Denmark, found that 76% of the respondents had informal contacts with employees in other firms in the cluster. 41% of the people with informal contacts extracted knowledge that was useful in the present job. However, less than 10% of the people who extracted knowledge from their informal contacts rated the value as high.

In line with Von Hippel (1987), Schrader (1991) found that information is traded between employees in different firms in the specialty steel and mini-mill industry in the US. In particular, Schrader (1991) found that 61% of technically oriented mid-level managers in the mini-mill industry regarded informal contacts with people outside their firms as being an important or very important information source. Only colleagues within the same firm were considered, on average, to be a more important source of information (other assessed sources were vendors, customers, professional journals and books, and presentations at conferences). Important to note, these firms were not generally located in clusters. Similar results have been found in the aerospace industry (Gavrilis, 1989, through Schrader, 1991). Von Hippel (1987) also referred to preliminary evidence of similar behaviours among aerospace firms and waferboard manufacturing firms. Consequently, informal contacts as a mechanism for diffusing knowledge between organisations is not constrained to a cluster phenomenon (c.f. Malmberg & Power, 2005).

Carter (1989) argued that the non rivalry nature of knowledge and the difficulties involved in valuating knowledge make barter a suitable mechanism for knowledge exchange. In this

bartering process, Schrader (1991) claimed that employees are mindful of the economic interest of their employers. He suggested three parameters that influence decisions whether to supply information to employees in other firms: (1) the degree of competition between the firms (high competition lowers likelihood of sharing knowledge); (2) alternative ways of obtaining the information (increases the likelihood of sharing knowledge); and (3) whether the information relates to areas in which the firms compete (if it does not, that increases the likelihood of sharing knowledge).

Notwithstanding peoples' propensity to form relationships with people similar to themselves (c.f. Westelius, 1996; McPherson et al., 2001), it is reasonable to assume that informal contacts with people outside the organisation, as compared with contacts with people inside the organisation, are more likely to span structural holes and consequently to contribute to the development of ideas (c.f. Burt 2004). Burt (2004) found, among other things, that positive performance evaluations and good ideas were disproportionately sited with people who span structural holes within the supply chain of a large electronics company in the US.

2.2. Labour mobility

Labour mobility, i.e. employees changing employers, is an aggregate measure of organisational employee turnover. These measures are inversely related to the average employee tenure, i.e. length of employment, measured at an individual level. Consequently, ceteris paribus, increasing labour mobility implies shorter average tenure.

Theoretically, March (1991) modelled organisational learning through labour mobility. His model illustrates that new employees learn from the organisation at the same time as the organisations learn from new employees. The model demonstrates how new employees might be sources of new knowledge even though they on average have less knowledge than long term employees.

Empirically, Song et al. (2001) found that international mobility of engineers (i.e. engineers moving from US firms to non-US firms) can play a substantial role in firms' technological catching-up. Song et al. (2003) showed that knowledge transfer is more likely to take place if the recruit possesses expertise in a field distant from the hiring firm and if s/he works in non-core areas of the new firm. This might be due to intentions to actively learn from a recruit, if s/he is employed to expand rather than reinforce the knowledge base. Willingness to learn from recruits is probably important. Westelius & Askenäs (2004) noted how recruits in low-status administrative positions were discouraged from changing procedures and routines, and were limited to faithfully reproducing the way their predecessor worked. Further linking labour mobility of highly skilled employees to knowledge diffusion, Zander & Kogut (1995) found that key employees leaving the organisation are associated with faster imitation by competitors.

Although many studies focus on knowledge flows to the new employer, Agrawal, Cockburn & McHale (2006) assessed knowledge flows from a job changer's new location to his or her former location, using patent citations. These types of knowledge flows are based on enduring social relationships. They found that knowledge flows to an inventor's prior location are approximately 50% greater than what would be expected should s/he never have lived there. They also found that knowledge flows are stronger across fields than within. The explanation for this, according to Agrawal et al. (2006), is that inventors in the same field often are part of the same "community of practice" and consequently meet and form ties even when not co-

located. I.e. for inventors in different fields, co-location increases the chance of forming ties more than for people in the same field.

On an individual level, higher salaries for more mobile workers are seen as an indication that individuals bring knowledge with them across organisational borders (Dahl, 2002). Further linking labour mobility to agglomeration, Almeida and Kogut (1999) showed that the mobility of engineers and inventors in the US semiconductor industry is higher in Silicon Valley than within other US regions. Other studies have confirmed that mobility is higher in clusters than in the general labour market (Dahl, 2002; Power & Lundmark, 2004). However, here we have to be careful with ascribing a causal relationship. At a national level, growth and labour mobility are correlated (e.g. Israelsson et al., 2003), but that could, perhaps, better be explained by people changing jobs more frequently when there is a pull in the vacancy chain rather than growth being caused by labour mobility.

Other scholars have taken a critical stance to the alleged positive effects of labour mobility. E.g. Michie and Sheehan (2003) found that employee turnover is negatively related to firm innovativeness. Furthermore, high inflows of new employees might lead to firms conserving their current practices (Madsen et al., 2003); and at an aggregate level – the national average employee tenure has an inverted U-shaped relation to countries' productivity per capita (Auer, et al., 2005). The latter authors' data suggest that "*there is no general problem of excessively long tenure in Europe*" (Auer et al., 2005, p. 329). However, these studies focus on mobility in general, not on mobility of key employees in particular. Lastly, even though attempts at encouraging voluntary labour mobility are known (Bienkowska 2007), most firms see the mobility of employees rather as a problem than as an advantage (c.f. Malmberg & Power, 2005; Bienkowska, 2007).

2.3. Knowledge-seeking behaviour & hypotheses

Homing in on how engineers and scientists actually seek knowledge, Anderson et al. (2001) found that aerospace scientists and engineers prefer oral sources of knowledge over written sources. Furthermore, they found that there is a preference for sources within the organisation to sources outside the organisation. In short, engineers seem to follow the principle of least effort in searching for information.

Further assessing sources of knowledge, Ibrahim et al. (2009), showed that inventors located inside clusters, as compared to inventors outside clusters, rely more on firm external but local sources of knowledge for their inventions. However, inventors rely more on corporate sources of knowledge than external sources in coming up with their inventions, regardless of location (Ibid). In Ibrahim's et al. (2009) study only local sources and corporate/organisational sources were assessed. Consequently, it is possible that engineers not in clusters compensated with informal contact that were neither organisational nor local.

As mentioned, as far as informal contacts with people outside the organisation are concerned, information is commonly traded and the interests of the employer are considered (Schrader, 1991; Dahl & Pedersen, 2004, Ensign & Hébert, 2009). Also within firms, people tally knowledge exchanges (Ensign & Hébert, 2010). However, within firms, uniqueness and value of the knowledge are positively related to the propensity to share it (Ensign & Hébert, 2010). One reason could be that within firms, the employer's interest more often works in favour of sharing knowledge. Inquiries for information or requests for training (e.g. "can you teach me how to...") are generally more legitimate and common between co-workers than through informal contacts outside the organisation. Furthermore, co-workers are likely to have similar

frames of reference, e.g. they are likely to belong to the same epistemic community and also to share a large part of organisation-specific knowledge. Last but not least, oral sources are preferred to written sources and colleagues are usually spatially close, allowing both planned meetings and higher probability of chance encounters. Consequently, from the perspective of an employee in a large organisation, co-workers are likely to be the most important source of knowledge regardless of whether the organisation is located in a cluster or not.

This leads to our first hypothesis:

H1: The most important source of knowledge is colleagues within the organisation

The literature suggests that informal contacts with people outside the organisation is an important knowledge sources in many organisations (e.g. Dahl & Pedersen, 2004; Schrader, 1991). Although the importance of informal contacts outside the organisation as a knowledge source has rarely been juxtaposed to other sources of knowledge, the literature suggests that they are more important than codified sources, both internal and external (Anderson et al., 2001). Thus:

H2: Informal contacts outside the organisation is a more important knowledge source than codified sources such as internal or external databases or scientific literature.

Furthermore, since people with contacts outside the organisations are more likely to span structural holes they are more likely to contribute creatively to product development projects (c.f. Burt, 2004). Therefore, hypothesis 3 (H3) suggests a positive relation between an employee's creative contribution to the project and the importance attributed to external sources of knowledge, such as suppliers, customers, partner organisations, and to informal contacts outside the organisation. This is separated into two hypotheses:

H3a: The higher an employee rates the importance of external parties, such as suppliers, customers and partner organisations as a knowledge source, the higher the employee's creative contribution to the project.

H3b: The higher an employee rates the importance of informal contacts outside the organisation as a knowledge source, the higher the employee's creative contribution to the project.

3. Empirical Setting & Methodology

This article assesses importance of different knowledge sources utilised by 219 participants in two high-tech, R&D driven, non-incremental, product development projects in large corporations. The projects are focused on the design and construction of what Moodysson et al. (2008, p. 1044) describe as "functional systems shaped as tangible and useful artifacts [sic] and technologies", e.g. the development of a new car or aeroplane.

Both corporations are located in local labour markets highly specialised in their respective industry clusters. They were identified as local clusters in an assessment by Lindqvist et al. (2002), which in turn is based on a translation of Michael E. Porter's model and categorisation of industry clusters (c.f. Porter 1990). The local labour markets are characterised by both employing a substantial part of the Swedish labour market within the respective industry cluster (>25%) and by being highly specialised in the industry cluster (the proportion of

people employed in the industry cluster is more than ten times higher than the national average, c.f. Lindqvist et al. (2002)).

Both corporations are important actors in their region and are partners in a regional network based on the Triple Helix principles (i.e. strengthened relationships between university, industry, and government to promote knowledge exchanges, innovation and entrepreneurship c.f. Etzkowitz & Klofsten, (2005)). Furthermore, both corporations are international and cooperate with both public and private organisations in developing new products; although the assessed projects are mainly local.

Both projects involved a vast majority of men (89% and 84%). Average age was 41 and 43 years old. Education was predominantly in science and engineering in both projects and the median education was 4.5 years of university in project A and 3 years of university in project B. 24% of the participants in project A and 9% in project B had at least one patent.

Through an interactive approach, in a group of academic researchers and practitioners from the focal organisations and other organisations in the above mentioned network based on the Triple Helix principles, a questionnaire was developed and tested by employees in four different organisations (by people neither involved in the focal projects nor included in the survey sample). The interactive group was also involved in discussing and interpreting results.

The questionnaire was sent, in the form of a web-based questionnaire accessible through e-mail invitation, to participants in four innovative projects in the participating organisations. Two of these projects fitted the criterion high-technology R&D-based non-incremental product development in large organisations and are the focal projects of this article. The other two projects focused on entrepreneurial projects in the public sector and are not covered in this article.

In project A, we sent 3 reminders resulting in a response rate of (124/149) 83%. In project B we were not allowed to send any reminders, leading to a considerably lower, but still acceptable, response rate of (158/499) 32% in project B. Respondents who where active less than 20% of full time (i.e. less than 8 h a week) in the projects were excluded from the analysis, since lower participation was deemed to jeopardise reliability. Consequently, we obtained 94 usable responses in project A and 125 in project B.

The questionnaire addressed background data of the respondents (e.g. age, education, time of employment and length of work experience); questions addressing the importance of different knowledge sources to the respondents acquisition of knowledge during the project; questions regarding their own self-assessed creative contributions to the projects; and we also asked the respondents to name people who they thought contributed particularly creatively to the project (e.g. contributed with new ideas or solutions). The questions regarding importance of knowledge sources and self-assessed creative contribution to the projects were measured using 7 point Likert-type scales. Respondents were informed that answers would be analysed exclusively by a group of independent researchers and that no answers traceable to single individuals would be released outside this group.

There was a difference between the people who were mentioned by co-workers as particularly creative and self-reported creative contribution of about half a standard deviation (*d*), i.e. a medium effect (Cohen, 1988), when measured in all four projects who responded to the survey, In the projects that we focus on in this article, the results were mixed. In project A,

there was no significant difference in self-reported creative contribution between people who were mentioned by others and people who were not. In project B this difference was significant (d= 0.7; n= 110, mean score=4.9/3.9 SD=1.4, t(108)=3.3, p<.001 [two-tailed]).

Assessing creative contributions in teams is difficult and assessments vary depending on perspective (c.f. Moneta et al. 2009). Particularly in large projects like these, participants will have limited knowledge about the contributions of all other participants. Furthermore, people's contributions are visible to other project members to various degrees, adding further noise to the peer-assessed measure. In order to compensate for this, the peer-assessed measure, i.e. number of mentions by others, was aggregated to a binary variable, where 0 means not mentioned and 1 means mentioned by at least one other participant. Since both peer and self-ratings are potentially biased, they should be seen as complimentary assessments of actual creative contributions to the projects.

In both projects, people mentioned on average one person each as particularly creative. Since there was a considerable discrepancy in response rate and people sometimes mentioned non-respondents, 33% in project A and 22% in project B were mentioned by at least one person.

One of the main reasons for asking people to mention others, whom they considered contributed particularly creatively to the project, was to attain alternative measures of the dependent variable, i.e. creative contributions to the projects. Despite our possibility to triangulate, potential common method variance (CMV, c.f. Podsakoff et al., 2003) should be addressed when assessing the relationship between the self-reported variables. Using Harman's method as described by Podsakoff et al. (2003), we conducted an exploratory factor analysis on all variables where CMV could be an issue. The results showed that the variables loaded on several factors and no one factor explained the majority of the variance. This indicates that CMV is not excessively influential in our dataset (Spector, 2006).

Hypotheses 1 and 2 were tested comparing the assessments of the importance of the different knowledge sources using paired sample t-tests. Hypotheses 3a and 3b were tested using two measures of creative contribution to the projects, self-assessed and peer-assessed. The samples are large enough for linear multiple regressions with a few independent variables (c.f. Tabachnick & Fidell 1996). Consequently, hypotheses 3a and 3b are firstly tested through a multiple regression where self-assessed creative contribution to the project is the dependent variable and the importance of external parties and informal contacts are independent variables (presented in Table A1. see Appendix A). Furthermore, we tested the solution in a stepwise regression controlling for tenure, number of hours spent on the projects ("time") and gender (presented in Table 1.). Preliminary analyses indicated no violation of the assumptions of linearity, normality of error terms, homoscedasticity and multicollinearity.

Since logistic regression is not advisable for samples of this size, in particular not for the sample in project A (c.f. Long, 1997; Peduzzi et al., 1996), we compared the importance of external parties and informal contacts as knowledge sources between participants who were mentioned by others as particularly creative with participants who were not, using independent sample t-tests (presented in Table 2.). Nevertheless, we tested if the differences found were robust to a logistic regression, despite the limited sample sizes. In line with the t-tests, only external parties came out as a significant predictor for both projects. However, for project A, the Omnibus Tests of Model Coefficients was just outside of the 5% significance level (p=.088).

In order to compensate for possible acquiescence biases/common scale formats bias, i.e. biases that could inflate relations between variables measured using Likert-type scales (c.f Podsakoff et al, 2003), we ran zero order correlations between the dependent variable and normalised ratings of the knowledge sources. We normalised the ratings of the sources by subtracting the respondents mean rating on all the rated sources. Consequently, normalised sources represent relative importance to other sources, where negative values represent below average value. This will arguably overcompensate for acquiescence biases/common scale formats bias, since using one source more does not necessarily mean using less of another, e.g. some people might actually use more sources than others. The results, shown in Table B1. (see Appendix B), indicate a significant positive relation between self-assessed creative contribution to the project and the relative importance of external parties (e.g. customers/partners/suppliers) as knowledge sources in both projects; and a significant positive relation between self-assessed creative contribution to the project and the relative importance of informal contacts outside the organisation as knowledge sources in project B. Self-assessed creative contribution was unrelated or negatively related to all other normalised knowledge sources. Correlation matrixes for the original knowledge sources and measures of creative contributions to the projects are shown in Table C1 and C2 in Appendix C.

4. Results

The ratings of the importance of the knowledge sources are depicted in Figure 1. On average, the highest rated knowledge source in both samples is colleagues within the organisation. This difference is statistically significant at the $p<.001$ level, using paired sample t-tests, in comparison with all other knowledge sources respectively for both projects.

In line with Dahl & Pedersen (2004) we find that informal contacts gained during the participant's career are prevalent. In project A, 87% report having at least one informal contact (with former colleagues, employers, class mates or customers/suppliers to previous employers), in project B this proportion is 86%. Of the people with at least one contact, 55%/77% report that the contact(s) is (are) of importance to their present work; 17%/19% report that the contact(s) is (are) of great importance to their present work.

Despite the prevalence and importance of informal contacts – they are not rated as important knowledge sources in the project. As shown in Figure 1., informal contacts got the lowest average ratings of all knowledge sources in both projects. The difference between informal contacts outside the organisation and all other knowledge sources respectively, is statistically significant (at the $p<.0005$ level, using paired sample t-tests) in project A. In project B informal contacts are significantly lower rated than all other knowledge sources (at the $p<.01$ level, using paired sample t-tests) except books/Specialist literature, (mean 2.6/2.8 *SD* 1.6/1.6 $t(112)=1.24$, $p=.22$, $d=0.14$).

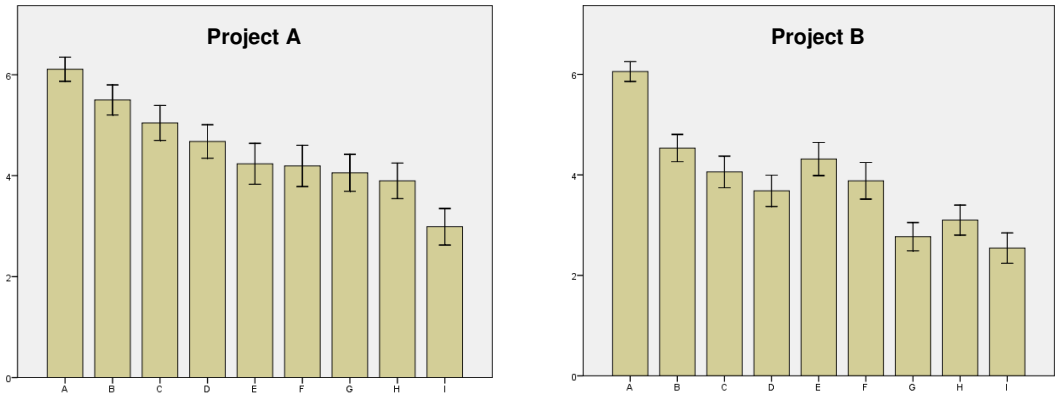

Figure 1. Assessment of knowledge sources. *Note:* Fig.1. depicts the ratings of knowledge sources in each project sorted ascending, based on the results in project A (A-Colleagues within the organisation; B-Time to reflect and think; C-Time to experiment/trial and error; D-Education; E-Intranet/internal documentation; F-External parties [e.g. customers/partners/suppliers]; G-Books/Specialist literature; H-Internet; I-Informal contacts outside the organisation). A 95% confidence interval is shown for each rating.

Table 1. Results from a hierarchical multiple regression, using self-assessed creative contribution in the project as the dependent variable.

	Project A				Project B			
Variable	Step 1	*P*	Step 2	*P*	Step1	*P*	Step 2	*P*
Tenure	-0.15	0.20	-0.092	0.40	0.20	0.045	0.13	0.15
Time	0.18	0.13	0.016	0.89	0.15	0.12	0.13	0.15
Gender	0.052	0.64	0.043	0.67	0.16	0.10	0.18	0.054
External parties			0.32	0.012			0.18	0.10
Infomal contacts			0.22	0.067			0.23	0.038
R^2	0.077	0.11	0.27	0.0005	0.091	0.020	0.21	0.0005
Adj- R^2	0.040		0.22		0.065		0.17	
F-value	2.10		5.33		3.42		5.44	
ΔR^2			0.19	0.0005			0.12	0.001
F-value for ΔR^2			9.47				7.79	

Table 2. Results from t-tests comparing the participants who were mentioned by others as contributing particularly creatively to the projects with participants who were not mentioned in each project, on their ratings of knowledge sources, using an independent-samples t-test (two-tailed).

	Project A					Project B				
Variable	Mean mentioned/ non-mentioned	*SD* mentioned/ non-mentioned	*t*	*d*	*p*	Mean mentioned/ non-mentioned	*SD* mentioned/ non-mentioned	*t*	*d*	*P*
External parties	4.7/3.9	1.5/2.1	(77.5) =2.13	0.5	.037	5.2/3.5	1.8/1.9	(115) =4.06	0.9	.0005
Infomal contacts	3.1/2.9	1.5/1.8	(84) =0.31	0.1	.76	3.0/2.4	2.1/1.5	(32.9) =1.32	0.3	.20

Comparisons between participants, who were mentioned by others as contributing particularly creatively to the projects, with participants who were not mentioned on the ratings of the other knowledge sources, gave no significant results in project A. In project B, mentioned participants had higher ratings of "Time to reflect and think" (mean= 5.2/4.4, *SD*=1.3/1.5, $t(119)=2.70$, $d=0.6$, $p=.008$) and "Time to experiment/trial and error" (mean= 4.8/3.8, *SD*=1.7/1.7, $t(117)=2.56$ $d=0.6$, $p=.012$). However, here we should consider that 14 comparisons were made, which has implications for the significance of these results.

In summary, the results show that, in these large R&D driven, non-incremental product development projects, the most important knowledge source is colleagues within the organisation (H1 supported). Informal contacts outside the organisation, although prevalent, are rather unimportant as knowledge sources for the participants (H2 rejected). External contacts are related to creative contributions in the projects regardless of whether the contributions are self-assessed or peer-assessed (H3 supported). The support for H3a is rather strong (See Table 1; 2; A1 & B1). However, the support for informal contacts outside the organisation being related to creative contributions to the project is limited to self-assessed contributions and even so, the link is marginally significant in project A (see Table 1; A1 & B1).

5. Discussion & Conclusion

Dahl and Pedersen (2004), who found that informal contacts are important channels of knowledge diffusion, specifically called for studies juxtaposing informal contacts to other knowledge sources. In doing so, we find that, despite reporting contacts from previous and present employments as important to their present work, the importance of informal contacts as a knowledge source is small, when compared to other knowledge sources. This clearly puts earlier findings (e.g. Dahl & Pedersen, 2004), not juxtaposing knowledge sources, in a new light. Thus, at first glance, the results in this study seem to side with Power & Lundmark (2004), in that knowledge at an individual level most commonly develops through interaction located in the workplace and not through informal contacts with people outside the organisation.

Are there idiosyncrasies related to the samples, e.g. the assessed industries as suggested by e.g. Von Hippel (1987)? In fact, one of our projects is in an industry that has been suggested as particularly rich in knowledge flows through informal contacts (e.g. Von Hippel, 1987; Schrader, 1991; Anderson et al., 2001). Regarding the difference to the results obtained by Dahl and Pedersen (2004), they surveyed 19 firms from the general population of members in NorCOM; our focal projects in this study are located in large organisations, dominant in their region. This might skew the balance required in knowledge trading, e.g. employees in the large dominant firms might consider other organisations having little to offer. Furthermore, non-competition clauses in the employment contracts are negatively related to the propensity to have informal contacts outside the firm (Dahl & Pedersen, 2004). In the focal projects of the present study both firms have such clauses in their contracts. However, a very high proportion of our respondents still reported keeping in touch with contacts made during their previous employments and benefitting from them in their present work.

Interestingly, Dahl & Pedersen (2004) reported that respondents in R&D had higher frequency of informal contacts than respondents in production, but respondents in production where more likely to acquire knowledge through their contacts. It is possible that the different patterns are due to the ease with which the types of knowledge relevant to work in production

and R&D respectively can be shared outside the organisation (c.f. Zellner & Fornahl, 2002). However, an alternative, and perhaps more probable, explanation for this is that unique knowledge, which can be assumed to be more common in R&D projects, is less likely to be shared outside the firm (c.f. Schrader, 1991).

This is in line with recent research arguing that high-technology small firms are unlikely to benefit from local research collaboration since much of their R&D *"is highly confidential, competitive and wholly internalised. This tendency [...] minimises the likelihood that local management collaboration between co-located firms will improve the performance of R&D projects."* (Oakey, 2007, p. 237). Bramwell et al. (2008), studying the Waterloo ICT cluster in Canada, also found little support for local actors being drivers of innovation; rather, they emphasise that innovation is driven "*primarily by global customers in conjunction with in-house R&D departments*"(p. 112).

Turning to Power's & Lundmark's (2004) statement that *"knowledge and innovation most commonly develop through interaction located in the workplace itself"*, we believe our results only partly supports it. It is clear that the individuals responding to our survey find the knowledge sources associated with the workplace as the most important e.g. colleagues within the organisation and time to reflect and think. However, studying knowledge flows at an individual level is but one piece in the puzzle; individual learning is not equivalent to organisational learning (Ellström, 2010).

Arguably, learning should be manifested in organisational routines, practices or action to contribute to organisational learning (c.f. Nelson & Winter, 1982). From an organisational perspective, required knowledge (for some context) might exist in the organisation but might not be embodied in people facing the context or different types of knowledge might not be coordinated to solve a problem (c.f. Zellner & Fornahl, 2002). Consequently, organisational learning is about creating new knowledge endogenously, absorbing knowledge from the outside as well as disseminating knowledge within the organisation.

To exemplify – a newly graduated student will most certainly learn much during his or her first year of employment. Notwithstanding the possibility that s/he might contribute to organisational learning (c.f. March, 1991), it is arguable that the individual will learn much and the organisation little during this year. This distinction is important since failing to make it can blur our understanding of knowledge flows.

What is learned from colleagues is by definition not new to the organisation. However, new knowledge can be created endogenously by e.g. experimentation and reflection. It can also be brought in from the outside. Our results indicate that external contacts are positively related to creative contributions, e.g. coming up with new ideas and solutions. Consequently, even though external contacts are not excessively important for individual learning it could be quite important for organisational learning. Interestingly, the people mentioned by others as particularly creative in project B were distinguished not only by significantly higher ratings of external parties as knowledge sources but also by significantly higher ratings of time to reflect and think and time to experiment/trial and error[3], i.e. potential sources of knowledge new to the organisation.

Thus, we argue that, although knowledge can be created endogenously within the organisation or through hiring, external contacts can be of higher importance to organisational learning than to individual learning. I.e. we side with Power & Lundmark (2004) with regards to

individual level knowledge development, but more research is needed before generalising this statement to organisational learning. In fact, our results suggest that external contacts are important to bringing new ideas into the organisation.

In line with the discussion above, labour mobility is often associated with substantial individual learning but only sometimes associated with substantial organisational learning. Furthermore, much knowledge is highly organisation specific and might be of no or little use in another organisation and consequently labour mobility might be associated with a loss of certain types of knowledge for the former employer without necessarily benefitting the new employer (c.f. Breschi & Lissoni 2001a). As a result, labour mobility can be wasteful from an organisational learning perspective. Knowledge gains and losses are difficult to measure or even to conceptualise. Although there is an abundance of knowledge typologies, better models are needed to develop our understanding of the effects of labour mobility and informal contacts for the diffusion of knowledge at different levels.

Notes

[1] Perhaps better known, Krugman (1991b) argues similarly that knowledge flows "leave no paper trail" (p. 53).
[2] Explicit knowledge is sometimes referred to as information (c.f. Zellner & Fornahl, 2002).
[3] However, the reader should note the high number of comparisons that were made when these results were found (see results section).

References

Acs, Zoltan J.; Braunerhjelm, Pontus; Audretsch, David B. & Carlsson, Bo (2009). The knowledge spillover theory of entrepreneurship. Small Business Economics, Vol. 32, No. 1, pp. 15-30.

Agrawal, Ajay; Cockburn, Iain & McHale, John (2006). Gone but not forgotten: knowledge flows, labor mobility, and enduring social relationships. Journal of Economic Geography, Vol. 6, pp. 571–591.

Almeida, Paul & Kogut, Bruce (1999). Localization of Knowledge and the Mobility of Engineers in Regional Networks. Management Science, Vol. 45, No. 7, pp. 905-917.

Anderson, Claire, J.; Glassman, Myron; McAfee, R. Bruce & Pinelli, Thomas (2001). An investigation of factors affecting how engineers and scientists seek information. Journal of Engineering and Technology Management, Vol. 18, No. 2, pp. 131 - 155"

Arrow, K. (1962). The economic implications of learning by doing. Reviewof Economic Studies 29, 155–172.

Audretsch, David, B. & Keilbach, Max (2005). The Moblity of Economic Agents as Conduits of Knowledge Spillovers. In Fornahl, Dirk, Zellner, Christian & Audretsch, David, B. (Eds.). The Role of Labour Mobility and Informal Networks for Knowledge Transfer. Springer Science/Business Media, Inc., Boston. ISBN 0-387-2314-2.

Auer, Peter; Berg, Janine & Coulibaly, Ibrahim (2005). Is a stable workforce good for productivity? International Labour Review, Vol. 144, No. 3.

Beaudry, Catherine & Schiffauerova, Andrea (2009). Who's right, Marshall or Jacobs? The localization versus urbanization debate. Research Policy, Vol. 38, No. 2, pp. 318–337

Bienkowska, D. 2007. 'Arbetskraftens rörlighet och klusterdynamik. En studie av IT-och telekomklustren i Kista och Mjärdevi'. [Labour mobility and cluster dynamics. A study

of ICT clusters in Kista and Mjärdevi, Sweden]. PhD Thesis Uppsala University. ISBN 978-91-506-1947-8.

Bramwell, Allison; Nelles, Jen & Wolfe, David, A. (2008). Knowledge, Innovation and Institutions: Global and Local Dimensions of the ICT Cluster in Waterloo, Canada. Regional Studies, Vol. 42, No. 1, pp. 101–116.

Breschi, Stefano & Lissoni, Francesco, (2001a). Knowledge spillovers and local innovation systems: a critical survey. Industrial and Corporate Change, Vol. 10, No. 4, pp. 975–1005.

Breschi, Stefano & Lissoni, Francesco, (2001b). Localised knowledge spillovers vs. innovative milieux: knowledge "tacitness" reconsidered. Papers in Regional Science Vol. 90, pp. 255–273.

Burt, Ronald, S. (2004). Structural Holes and Good Ideas. The American Journal of Sociology, Vol. 110, No. 2, pp. 349-399.

Carter, Anne, P. (1989). Knowhow trading as economic exchange. Research Policy, Vol. 18, No. 3, pp. 155–163.

Cohen, Jacob (1988). Statistical Power Analysis for the Behavioral Sciences (second ed.). Lawrence Erlbaum Associates.

Cohen, Wesley, M. & Levinthal, Daniel, A. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation. Administrative Science Quarterly, Vol. 35, No. 1, pp. 128-152.

Dahl, Michael, S. & Pedersen, Christian Ø., R. (2004). Knowledge flows through informal contacts in industrial clusters: myth or reality? Research Policy Vol. 33, No. 10, pp. 1673–1686.

Dahl, Michael, S. (2002). Embedded knowledge flows through labor mobility in regional clusters in Denmark. Paper presented at DRUID's New Economy Conference, Copenhagen, 6-8 June.

Ellström, Per-Erik (2010). Organizational Learning.In B. McGaw, P. L. Peterson, & E. Baker (Eds.) (forthcoming). International Encyclopedia of Education, 3rd Edition. Amsterdam: Elsevier

Ensign, Prescott, C. & Hébert, Louis (2009). Competing explanations for knowledge exchange: Technology sharing within the globally dispersed R&D of the multinational enterprise. Journal of High Technology Management Research, Vol. 20, No. 1, pp. 75–85

Ensign, Prescott, C. & Hébert, Louis (2010). How Reputation Affects Knowledge Sharing Among Colleagues. MIT Sloan Managment Review, Vol. 51, No. 2, pp. 78-81.

Etzkowitz, Henry & Klofsten, Magnus (2005). The innovating region: toward a theory of knowledge-based regional development. R&D Management, Vol.35, No. 3, pp. 243-255.

Florida, Richard (2002). The economic geography of talent, Annals of the Association of American Geographers, 92(4), pp. 743–755.

Fornahl, Dirk; Zellner, Christian & Audretsch, David, B. (2005). The Role of Labour Mobility and Informal Networks for Knowledge Transfer. Springer Science/Business Media, Inc., Boston. ISBN 0-387-2314-2.

Gavrilis, Theofanis G. (1989). Information Transfer Networks in Aerospace, Master's Thesis, Sloan School of Management, Massachusetts Institute of Technology.

Glaeser, Edward, L.; Kallal,Hedi, D.; Scheinkman, Jose, A. & Shleifer, Andrei (1992). Growth in Cities. Journal of Political Economy, Vol. 100, No. 6, pp. 1126-1152.

Ibrahim, Sherwat E.; Fallah, M., Hosein & Reilly, Richard, R. (2009). Localized sources of knowledge and the effect of knowledge spillovers: an empirical study of inventors in the telecommunications industry. Journal of Economic Geography, Vol. 9, No. 3, pp. 405–431.

Israelsson, Torbjörn; Strannefors, Tord & Tydén, Hans (2003). Geografisk rörlighet och arbetsgivarbyten [Geographical Mobility and Changes of Employer]. Stockholm: Arbetsmarknadsstyrelsen.

Jacobs, Jane., 1969. The Economies of Cities. Random House, New York.

Jaffe, Adam, B.; Trajtenberg, Manuel, & Henderson, Rebecca (1993). Geographic localization of knowledge flows as evidenced by patent citations. Quarterly Journal of Economics, Vol. 108, No. 3, pp. 577-598.

Kim, Jinyoung; Lee, Sangjoon, John & Marschke, Gerald (2006). International Knowledge Flows: Evidence from an Inventor-Firm Matched Data Set. Working paper available at http://www.nber.org/papers/w12692.

Klofsten, Magnus; Heydebreck, Peter & Jones-Evans, Dylan (2009). Transferring good practice beyond organizational borders: Lessons from transferring an entrepreneurship programme, Regional Studies, Regional Studies, First published on: 14 September 2009 (iFirst) pp. 1-9.

Krugman, Paul (1991a). Increasing Returns and Economic Geography. The Journal of Political Economy, Vol. 99, No. 3, pp. 483-499. http://www.jstor.org/stable/2937739

Krugman, Paul, R. (1991b). Geography and Trade. Leuven University Press, Leuven, Belgium. ISBN: 0262111594

Lindqvist, Göran; Malmberg, Anders & Sölvell, Örjan (2002). Svenska klusterkartor En statistisk inventering av kluster i Sverige 2002 [In Swedish: Swedish cluster maps a statistical assessment of clusters in Sweden 2002]. Centre for Research on Innovation and Industrial Dynamics, Uppsala Universitet

Long, J., Scott (1997) Regression Models for categorical and limited dependent variables. Sage Publications, Thousand Oaks London.

Madsen, Tammy L.; Mosakowski, Elaine & Zaheer, Srilata (2003). Knowledge Retention and Personnel Mobility: The Nondisruptive Effects of Inflows of Experience. Organization Science, Vol. 14, No. 2, pp. 173-191.

Malmberg, Anders & Power, Dominic (2005). (How) Do (Firms in) Clusters Create Knowledge? Industry and Innovation, Vol. 12, No. 4, pp. 409–431.

March, James G. (1991) Exploration and Exploitation in Organizational Learning. Organization Science, Vol. 2, No. 1, pp. 71-87.

Marshall, Alfred (1890/1920). Principles of Economics. MacMillan, London.

McPherson, Miller; Smith-Lovin, Lynn & Cook, James, M. (2001). Birds of a Feather: Homophily in Social Networks. Annual Review of Sociology, Vol. 27, pp. 415-444

Michie, Jonathan & Sheehan, Maura (2003). Labour market deregulation, 'flexibility', and innovation. Cambridge Journal of Economics, Vol, 27, pp. 123-143.

Moneta, Giovanni B.; Amabile, Teresa M.; Schatzel, Elizabeth A. & Kramer, Steven J.(2009). Multirater assessment of creative contributions to team projects in organizations. European Journal of Work and Organizational Psychology, forthcoming http://dx.doi.org/10.1080/13594320902815312.

Nelson, Richard, R. & Winter, Sidney, G. (1982). An Evolutionary Theory of Economic Change. Harvard University Press Cambridge, MA.

Nonaka, Ikujiro & Toyama, Ryoko (2003). The knowledge-creating theory revisited: knowledge creation as a synthesizing process. Knowledge Management Research & Practice Vol. 1, No. 1, pp. 2–10

Oakey, Ray (2007). Clustering and the R&D management of high-technology small firms: in theory and practice. R&D Management, Vol. 37, No. 3, pp. 237-248.

Peduzzi, Peter; Concato, John; Kemper, Elizabeth; Holford, Theodore, R. & Feinstein Alvan, R. (1996). A simulation study of the number of events per variable in logistic regression analysis. Journal of Clinical Epidemiology Vol. 49, No. 12, pp. 1373-1379.

Pennings, Johannes, M. & Wezel, Filippo Carlo (2007). Human Capital, Inter-firm Mobility and Organizational Evolution. Edward Elgar Publishing, Inc. Northampton, Massachusetts, USA. ISBN 9781845427573

Podsakoff, Philip, M.; MacKenzie, Scott, B.; Lee, Jeong-Yeon & Podsakoff, Nathan, P. (2003). Common method biases in behavioral research: a critical review of the literature and recommended remedies. Journal of Applied Psychology 88 (5), 879–903.

Polanyi, Michael (1966). The Logic of Tacit Inference. Philosophy, Vol. 41, No. 155, pp. 1–18.

Porter, Michael E, 1990. The competitive advantage of nations, Simon & Schuster: New York.

Power, Dominic & Lundmark, Mats (2004) Working through knowledge pools: labour market dynamics, the tranference of knowledge and ideas, and industrial clusters, Urban studies, Vol. 41, No. 5&6 pp. 1025-1044.

Rogers, Everett M. (2003) Diffusion of Innovations, 5th ed, The Free Press, New York, USA

Romer, Paul, M. 1986. Increasing returns and long-run growth. Journal of Political Economy 94, 1002–1037.

Saxenian, AnnaLee (1994). Regional Advantage: Culture and Competition in Silicon Valley and Route 128. Harvard University Press, Cambridge.

Schrader, Stephan (1991). Informal technology transfer between firms: co-operation through information trading. Research Policy Vol. 20, No.2, pp. 153–170.

Song, Jaeyong; Almeida, Paul & Wu, Geraldine (2001). Mobility of engineers and cross-border knowledge building: The technological catching-up case of Korean and Taiwanese semiconductor firms. Henry Chesbrough, Robert Burgelman, (Eds.). Research on Technological Innovation, Management and Policy, Vol. 7, pp. 59-84. Elsevier, New York.

Song, Jaeyong; Almeida, Paul & Wu, Geraldine (2003). Learning-by-Hiring: When Is Mobility More Likely to Facilitate Interfirm Knowledge Transfer? Management Science, Vol. 49, No. 4, pp. 351–365.

Sorenson, Olav; Rivkin, Jan, W. & Fleming, Lee (2006). Complexity, networks and knowledge flow. Research Policy Vol.35, No. 7, pp. 994–1017

Spector, Paul, E. (2006). Method variance in organizational research: truth or urban legend? Organizational Research Methods, Vol. 9, No. 2, pp. 221–232.

Storper, Michael & Venables, Anthony, J. (2002). Buzz: the economic force of the city. Paper presented at DRUID Summer Conference on "Industrial Dynamics of the New and Old Economy—Who Is Embracing Whom?", Copenhagen/Elsinore, June.

Szulanski, Gabriel (1996). Exploring Internal Stickiness: Impediments to the Transfer of Best Practice Within the Firm. Strategic Management Journal, Vol. 17, No. pp. 27-43

Tabachnick, Barbara G. & Linda, S. Fidell. 1996. Using multivariate statistics (third edition). HarperCollins, New York, New York, USA.

Westelius, Alf & Askenäs, Linda (2004). Getting to know your job – a social actor perspective on using information technology, Information Technology Journal, Vol. 3, No. 3, pp. 227-239.

Westelius, Alf (1996). A study of patterns of communication in management accounting and control projects, EFI, Stockholm.

Von Hippel, Eric (1987). Cooperation between rivals: informal knowhow trading. Research Policy, Vol. 16, No. 6, pp. 291–302.

Zander, Udo & Kogut, Bruce (1995). Knowledge and the Speed of the Transfer and Imitation of Organizational Capabilities: An Empirical Test. Organization Science Vol. 6, No. 1, pp. 76-92.

Zellner, Christian & Fornahl, Dirk (2002). Scientific Knowledge and Implications for its Diffusion. Journal of Knowledge Management, Vol. 6, No. 2 pp. 190-198.

Appendix A

Table A1. Results from a standard multiple regression, dependent variable self-assessed creative contribution in the project.

	Project A		Project B	
Variable	Beta/value	*p*	Beta/value	*P*
External parties	0.35	.003	0.16	.15
Infomal contacts	0.22	.059	0.27	.014
R^2	0.26		0.14	
F	13.2	.0005	8.7	.0005

Appendix B

Table B1. Correlations between normalised ratings of the knowledge sources and the self assessed creative contribution of the projects.

Normalised knowledge sources	Self-assessed creative contribution (Project A)	Self-assessed creative contribution (Project B)
Colleagues within the organisation	-.30**	-.33**
External parties (e.g. customers/partners/suppliers)	.26*	.20*
Informal contacts outside the organisation	Ns	.22*
Education	-.24*	Ns
Internet	Ns	Ns
Intranet/internal documentation	Ns	-.29**
Books/Specialist literature	Ns	Ns
Time to experiment/trial and error	Ns	Ns
Time to reflect and think	Ns	Ns

*$p < .05$, **$p < .01$. *Note:* The ratings of the knowledge sources are normalised by subtracting the respondents mean rating on all the rated sources. Thus, normalised sources represent relative importance to other sources, where negative values represent below average value.

Appendix C

Table C1. Correlation matrix project A

Variable	1	2	3	4	5	6	7	8	9	10
1 Self-rated creative contribution										
2 Mentioned as creative (binary)	.05									
3 Colleagues within the organisation	.10	-,07								
4 External parties (e.g. customers/partners/suppliers)	.47**	.20	.08							
5 Informal contacts outside the organisation	.40**	.03	-.18	.52**						
6 Education	.12	-.11	.21	.13	.35**					
7 Internet	.37**	.03	.06	.51**	.53**	.32**				
8 Intranet/internal documentation	.31**	.09	.25*	.38**	.24*	.24*	.46**			
9 Books/Specialist literature	.27*	-.11	.14	.17	.37**	.49**	.37**	.37**		
10 Time to experiment/trial and error	.31**	-.14	.37**	.20	.23*	.27*	.30**	.29**	.52**	
11 Time to reflect and think	.38**	-.08	.24*	.27*	.23*	.10	.21	.25*	.40**	.77**

*$p < .05$, **$p < .01$.

Table C2. Correlation matrix project B

Variable	1	2	3	4	5	6	7	8	9	10
1 Self-rated creative contribution										
2 Mentioned as creative (binary)	.30**									
3 Colleagues within the organisation	-.10	.10								
4 External parties (e.g. customers/partners/suppliers)	.31**	.35**	.08							
5 Informal contacts outside the organisation	.36**	.15	-.23*	.54**						
6 Education	0.11	-.13	-.02	.20*	.33**					
7 Internet	.21*	.08	-.02	.42**	.35**	.27**				
8 Intranet/internal documentation	-.09	.00	.29**	.04	-.04	.33**	.24**			
9 Books/Specialist literature	.22*	.08	.10	.20	.29**	.43**	.41**	.19*		
10 Time to experiment/trial and error	.28**	.23*	.13	.37**	.31**	.39**	.32**	.14	.31**	
11 Time to reflect and think	.30**	.24**	-.01	.35**	.27**	.29**	.22*	.06	.14	.67**

*$p < .05$, **$p < .01$.