CROSS-SECTOR RESEARCH ON KNOWLEDGE MANAGEMENT PRACTICES FOR PROJECT-BASED LEARNING

by

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Paper submitted to *Innovative Research in Management*,
European Academy of Management 2nd Annual Conference,
(Sub-theme: Organisational Learning and Knowledge Management),
Stockholm, Sweden, 9-11 May 2002

Abstract: Capturing and diffusing the knowledge generated on projects is highly problematic due to the idiosyncratic, complex and dynamic nature of projects. In particular, the recurrent re-organisation required by projects – especially the constant re-formation of project teams – militates against the systematic codification of knowledge or its embodiment in the knowledge base of project teams. This paper reports on on-going research in the UK that is designed to explore organisational and other factors inhibiting and enabling project-based learning. Our research compares and contrasts project-based learning across a range of industrial sectors (including medical technology, telecommunications, health and public services). It emphasises the inherently social nature of project-based learning and the difficulties this creates for attempts to capture and codify project-based learning.

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1. Introduction

Project–based forms of organising are increasingly adopted across a range of industry sectors on the premise that they offer more flexible and responsive alternatives and thus, enhance the innovative capability of the organisation by increasing flexibility and opportunities for cross-functional learning (Bolwijn and Kumpe, 1990). In particular, the prospect of capturing the learning from project-based work and making it available to other projects and the wider organisation as 'best practice' is a particularly attractive one, offering significant potential benefits of more resource-effective and flexible responses to new tasks and problems. Seizing these advantages, however, involves overcoming significant barriers to the capture of project-based learning due to the very nature of project-based work. In particular, a key problem in relation to project-based work is the transfer of learning from one project to another or 'internal stickiness' (Szulanski, 1996) whereby each newly formed project starts anew rather than learning from what has been done previously (Prusak, 1997), a tendency to 'reinvent the wheel' (Wah, 1999) which is all too common in project work and needs to be addressed.

In response to these concerns, our research undertaken in the UK across a range of industrial sectors including construction, pharmaceuticals, telecommunications, health and public services explores the extent to which such re-invention can be avoided. This paper reports on a comprehensive and systematic analysis of knowledge management practices across and between projects in the different sectors and in particular, the interaction between the processes of learning capture and the wider organisational context. The central aim of the paper is to illustrate the key processes and mechanisms involved in capturing and re-using project-based learning across a range of business sectors. It primarily focuses on the roles played by project, process and team characteristics, knowledge management practices and informal networks. The paper describes the impact of these different dimensions through a comparative analysis of original detailed case studies of knowledge management practices for project-based learning. By providing a systematic analysis of knowledge management practices across a range of different types of project-based work, the paper offers a novel perspective on the challenges that organisations face when attempting to encourage knowledge sharing across projects. The analysis also demonstrates that in some instances reinvention may be desirable to ensure attitude change and acceptance for externally generated ideas. In sum, the paper addresses a comparatively under-researched but nonetheless vital aspect of project-based work: the context-specific behavioural and organisational factors that are critical to the capture of project-based learning (Scarbrough and Swan, 1999) and 'best practice' transfer (Camp, 1989).

The next section establishes the theoretical rationale and examines the contribution of the existing literature on the management of organisational knowledge in a project-based work context and. Then section 3 describes the methodology used in the reported study. A cross-case analysis follows in section 4. In the final section, the theoretical and practical implications of the analysis are drawn together as a matter of concluding comments.

2. Theoretical rationale

The move towards project-based organisation may significantly enhance the innovative capability of the firm by increasing flexibility and opportunities for cross-functional learning (Bolwijn and Kumpe, 1990). Seizing these

advantages, however, involves overcoming significant barriers to the capture of project-based learning. A our findings suggest, these barriers to the recycling of project-based learning arise from the distinctive character of project work - self-contained tasks that are highly discontinuous on a number of dimensions (i.e. personnel, time, space, information flows). The resulting problems of transferring knowledge across projects or between different project phases mean that the tendency to 'reinvent the wheel' (Wah, 1999) is all too common in project-based work.

In this context, identifying, understanding and overcoming barriers to effective knowledge management is central to the development and maintenance of competitive advantage, while common understanding suggests that "*the role of knowledge management is to leverage and reuse resources that already exist in the organisation so that people seek out best practices rather than reinvent the wheel*" (Wah, 1999: 16). However, much of the existing work addressing these issues primarily attempts to identify and promote universal models of knowledge management, often depicting knowledge management as an unvarying set of tools and techniques that can be used in any context (e.g. Fahey, 1998; Zack, 1999) rather than the actual factors affecting effective knowledge management practices in particular contexts. Yet given the range, complexity and variability of projects it is also likely that there would be significant variation in practices for different kinds of projects both within and across organisations.

Existing approaches tend, then, to under-emphasise the context-specificity of knowledge and the ways in which the creation, transfer and application of knowledge, and therefore its management, are influenced by context (Blackler, 1995). Accordingly, most tools and methodologies for knowledge management have tended to adopt a *cognitive* model of knowledge management whereby valuable knowledge can be codified and circulated more widely through the application of information communication technologies (Cole-Gomolski, 1997). However, this model has been challenged by studies that question its emphasis on knowledge codification through technology (Spender, 1996; Swan et. al, 2000). In response, more recent approaches have stressed the need to adopt a *community* model that focuses on the tacit dimension of knowledge (Sanchez and Heene, 1997). This assumes that knowledge transfer involves developing some level of shared meaning that allows one group to understand and apply another's insights and knowledge within their own context (Weick, 1995; Spender, 1996; Senge, 1990). In particular, this highlights the problems of inter-project knowledge transfer between groups that are spatially and culturally differentiated. The community model thus emphasises the social and behavioural aspects of knowledge management, in particular individual motivation and social networks, including the cultivation of trust, norms and shared values amongst 'communities of practice'. These social processes are seen as impacting the organisation's ability to manage knowledge and constraining the effectiveness of information communication technologies for knowledge management (Pan and Scarbrough, 1998; McLoughlin, 1999). The social processes of knowledge management are also influenced by the wider institutional and organisational context (Teece, 2001). For example, organisational structures impose barriers around networking and the development of 'communities of practice' (Brown and Duguid, 1998). Similarly incentive structures may influence the willingness of individuals to engage in knowledge capture and transfer practices (Keegan, 1998). Thus, the community model highlights the extent to which the creation, transfer and application of knowledge is influenced by the context of practice, including sectoral context (Pavitt, 1984). Taken together, the cognitive and community models suggest the range

of dimensions and interventions that may be important for the capture and transfer of learning, and the mediating role of organisational and institutional context in the effectiveness of such interventions (Teece, 2001).

Our research identifies the ways in which knowledge management practices in project-based work need to be aligned with critical features of the context. This includes contextual features associated with the project and its purpose, the organisation and the sector (Pavitt, 1984; Spender, 1989). Critical enablers and barriers to managing knowledge for project-based learning may vary across sectors, hence the need for a broad cross-sectoral study that our research addresses. That said, although organisations across sectors may produce different products, they may well share similar organisational characteristics and therefore similar problems in their *processes* for managing knowledge. Current research nevertheless says comparatively little about knowledge management in project-based work across sectors despite this being an especially critical issue. Nor does it offer specific, robust or validated tools to analyse knowledge management *across* projects. Hence a broad ranging, exploratory study drawing holistically on both cognitive and community approaches was particularly timely in order to develop a framework for analysing barriers and enablers within project-based environments across a range of sectors. The next section describes the methods and instrumentation used in the development of the findings reported in this paper.

3. Methods and instrumentation

This paper covers the findings of a one-year scoping study designed to research knowledge management practices for project-based learning across a range of sectors in the UK. This study is part of a larger, continuing research project started in fall 2000 with a one-year scoping study and a main research building on the scoping study due for completion in fall 2003, thus allowing scope for longitudinal insights.

Our research is a collaborative venture with five leading organisations representing a range of different industrial sectors and interests: construction, pharmaceuticals, telecommunications, health and public services where project-based work has become the norm rather than the exception, thus creating increasing pressure for more intensive exploitation of knowledge and learning generated. Each of these organisations thus had a keen interest and active involvement in knowledge management for project-based learning and their inclusion in our research provided an excellent opportunity to explore points of comparison and contrast between sectors and organisations.

Our research adopted a combination of quantitative and qualitative methods to support detailed case studies of knowledge management practices and extensive surveys of attitudes across the collaborating organisations. Qualitative case studies allowed to explore the phenomenon of interest in its natural setting and were used because usually particularly appropriate when the boundaries between the phenomenon and its context are not clearly evident (Yin, 1989). Also, given the closely coupled relationship between replication and firm processes, case studies were ideally suited to examine the linkage between knowledge development and transfer and the contexts in which these activities occur (Spender, 1996). Project probes, involving thirty six interviews with focal members of the project teams and attendance at a number of project team meetings, were carried out to examine the capture and transfer of project-based learning in the five organisations. In all cases selected projects were

innovation projects concerning the development of new ideas, organisational practices and/or products/services. The project probes investigated the generation and capture of learning within the project team, and inward/outward knowledge transfer to and from other groups. This was complemented by a quantitative, survey-based audit of internal attitudes and practices towards knowledge management of a much larger sample of project teams, which aimed to identify critical relationships between these key elements and consequent implications for the effectiveness of knowledge management practices. Beyond these site-specific insights, an integral part of the scoping study was the use of workshop events involving the collaborating organisations. These workshops provided the opportunity for participants with a forum to exchange ideas and experiences regarding problems and opportunities for project-based learning.

Data were coded and analysed according to seven key areas: project characteristics; project process characteristics; networking; project learning capture; organisational context; knowledge transfer and outcomes. These key areas were identified through a combination of deduction from existing theory and induction from the cases themselves. The main findings are analysed in turn following these seven key areas in the next section.

4. Main findings

This section presents the key findings structured around the contextual setting of the different cases. The key dimensions of project characteristics, project process characteristics, networking, project learning capture, organisational context, and knowledge transfer and outcomes are illustrated and discussed in turn against the project and contextual factors of each case.

4.1. Project and contextual factors

4.1.1. Construction and the regional engineering manager project

This project involves the introduction of a new role, the Regional Engineering Manager (REM), into an established regionally-divisionalised a UK-based construction company, ConstructionCo. ConstructionCo operates primarily in building, civil engineering and marine/water work and, to a lesser extent, in small projects and heavy plant provision. The creation of the REM position was part of a broader internal transformation process that began in the mid-1990s, and which saw the company change from a traditionally more adversarial approach to contracting to a more collaborative style. The aim of introducing the new role was to contribute towards profitability by increasing the value engineering of projects, as well as to improve the co-ordination of engineering services provision and engineers' training and development across the regions. The REM project is therefore seen as something of a conduit for the spread of engineering-based knowledge and project-based learning throughout the company. The project can also be understood as the establishment of knowledge management mechanism in its own right, which draws upon engineers' experiences on past and present construction projects. However, it is clearly much more of a 'process-based' project and one which has led to the establishment of a generic system for transmitting information and ideas across the firm as a whole.

4.1.2. Health services and the cataract process redesign project

HealthSer is one of a large number of trusts that together make up the UK National Health Service (NHS). The NHS having in recent years been plagued with a series of shortages with respect to staff, theatres and beds, as well as untenably long lead-times for non-life threatening procedures, needed a reengineering of its systems and procedures. One of the areas targeted by the government as in need of change was the cataract diagnosis and treatment procedure. Cataract surgery, which is a 20-minute, outpatient procedure, represents 96% of the ophthalmology workload. Traditionally, cataract diagnosis and treatment took a number of visits to various specialists. Only when all of the six or more visits to different specialists were complete would the patient get in the queue for obtaining a date for the cataract surgery. In many NHS trusts, lead-time for cataract surgery was over 12 months. Given the complexity and long-drawn out nature of this existing process, a new reengineered cataract diagnostic and treatment process was seen as potentially beneficial. To facilitate that change, a designated member of the hospital's transformation team was assigned to the process. The transformation team member gathered a team of eye experts from both the hospital and the community for a series of meetings to discuss ways in which to cut surgery lead times and improve patient satisfaction. The new cataract procedure has resulted in a number of efficiency gains. Lead times have been radically reduced from over 12 months down to six to eight weeks. In addition, theatre utilisation rates have improved due to the addition of an administrator whose sole responsibility is scheduling theatres. Finally, and most importantly, patient satisfaction has improved dramatically.

4.1.3. Pharmaceuticals and the prostate cancer therapy project

PharmaCo is a functionally-focused and geographically decentralised-organisation type pharmaceutical company with operations in several countries and continents. The prostate cancer therapy (PCT) project at PharmaCo involved the development and marketing of radioactive iodine seeds therapy for PCT by generating a community of practice around the treatment. These included a large number of different specialists, not only those involved in delivering the treatment (i.e. general practitioners, physicians, specialist urologists radiographers, nursing specialists) but also those with a vested interest in its use (e.g. patients, charity groups), and this at an international scale. The project lied outside both PharmaCo's main business and its main structure as this was the first time PharmaCo had ventured into the therapy business. This case thus concerned with the diffusion of an innovation that is highly interactive involving multiple stakeholders (e.g. urologists, radiation oncologists) in multiple institutional contexts (i.e. different countries with very different healthcare arrangements), thus providing scope for cross project-based learning both across national projects and across groups of specialists external to the company involved in the treatment.

4.1.4. Telecommunications and the technology watch project

At the time of the research start it was recently decided within TelecomCo that the company would not develop solutions internally in order to support its business but would buy solutions/applications from other companies, a 'buy not make' strategy. The company had also very recently been broken up into discrete business units, each operating as an independent company. These two strategic decisions meant that all those involved in the

R&D site had experienced considerable change and many had been left feeling unclear about how they fitted in or what their long-term future with the company was. The technology watch project involved analysing external companies in order to identify those with whom TelecomCo could potentially work. Given the buy not make strategy, the identification of such potential partnerships and alliances was clearly extremely important. Indeed, the activity was so important that many projects within TelecomCo had a technology watch aspect to them. However, sitting alongside the technology watch activity going on in all these separate projects is one project that was dedicated to this activity. This project consisted of a core team of two people who were provided, from a variety of sources, with leads on companies that might be worth investigating. They undertook a very preliminary investigation and then identified someone within TelecomCo who has the knowledge and expertise of the particular technology that this company was involved in, to conduct a more thorough analysis. This analysis was compiled as a report and sent to their sponsor in senior management who would use the information in this report, alongside his own knowledge and 'gut feel', to make a decision about whether to work more closely with this company.

In our study, despite sectoral diversity, organisations experienced remarkably similar barriers and enablers in managing knowledge for project based learning. For example, the PharmaCo and HealthSer organisations operated in very different sectors but faced similar problems in terms of managing knowledge transfer across heterogeneous professional groups. More generally, all of projects confronted problems of capturing learning under conditions of uncertainty – a chronic feature of innovations. In addition, all the projects involved to some degree the development of new organisational processes and therefore operated outside more mainstream organisational tasks. Project-based learning thus derived in large part from the need to bring together existing forms of knowledge in new ways in a context of uncertainty and risk. As a result, the key enablers and barriers to knowledge management were found to centre less on the capture of knowledge through ICTs and more on social processes and organisational factors.

A prerequisite for the development of a propositional framework of project-based learning dimensions was the development of a set of standardised descriptors of projects that could be usefully applied across different sectors. Illustrative examples from critical enablers and barriers in project probes are summarised in Table 1 across seven key areas: project characteristics; project process characteristics; networking; project learning capture; organisational context; knowledge transfer and outcomes, which provide the basis for these standardised descriptors.

Table 1: **Enablers and Barriers to Effective Knowledge Capture for Project-Based Environments**

Enablers	Barriers
Project Characteristics Bounded size/scope of project: *Project based at single location at SocialSer and TelecomCo* Tangible nature of innovation: *Bounded product innovation - development of new treatment at HealthSer*	**Project Characteristics** Open ended size/scope of project: *Project distributed across multiple geographical locations at ConstructionCo and PharmaCo* Intangible nature of innovation intangible: *Process innovation - new management roles & structures at ConstructionCo*
Project Process Characteristics Developing a shared language/ideology around project: *Common value placed on patient well being promotes legitimacy of projects in HealthSer and PharmaCo* Developing trust/norms for knowledge sharing: *Regional Engineering Managers in ConstructionCo create, build and maintain collaborative relationship based on strong social ties and reciprocity*; *Norms in SocialSer shift to team working for customer service delivery* Committed project champion: *Respected medical consultant champions project to others in HealthSer* Appropriate incentives and motivation: *'Transformation team' at HealthSer provides resources and expertise to facilitate knowledge creation & transfer; Identity with successful therapy in PharmaCo provides motivation for project members to share learning* Adequate resources: *Necessary slack in time to reflect on experience and identify implications of project learning for others at ConstructionCo* Training and education: *Company wide training and development in ConstructionCo provides forum for engineers to share knowledge and exchange contacts* Appropriate breadth/depth skills & expertise among team members: *Team in PharmaCo possess multidisciplinary expertise (scientific, medical skills and management) necessary to communicate project learning to other groups in their own 'language'* Linking pin individuals: *Same person on related teams in US and UK in PharmaCo; Linking pin REM role at ConstructionCo; Academic consultant at SocialSer links project to other relevant projects; Medical consultant links project with outside professional communities at Health*	**Project Process Characteristics** Differences in perceptions/ beliefs among project team and between team and other relevant groups: *Multiple professional and occupational groups in PharmaCo (e.g. sales staff and medical practitioners), HealthSer (e.g. secretaries and consultants) hold different perceptions about benefits of project learning and its relevance; Learning from 'technologist' projects in TelecomCo stereotyped as 'sandal loving' (i.e. blue sky/lacking commercial awareness) by commercial groups* Lack of trust: *Different contractual/commercial relations across regions and organisational boundaries in ConstructionCo inhibits development of trust necessary for knowledge sharing* Lack of appropriate incentives and motivation: *localised structures for rewards and career development in PharmaCo and TelecomCo do not encourage learning across task areas and divisions; Lack of recognition at TelecomCo for those who develop (versus those who exploit) new ideas and project learning; Cross-functional projects do not align with organisational incentive and career development structures (e.g. in PharmaCo and TelecomCo).* Discontinuities within and across project teams: *High turnover within and across project teams at TelecomCo disrupt learning capture form projects* Inadequate resources*; team in TelecomCo lack necessary time to reflect on learning that could be appropriate for others* Lack of skills & expertise among team members: *Teams at SocialSer lack appropriate project and change management skills needed for learning capture.*
Networking Personal networks with other groups in organisation: *face to face networking between project team and senior management, manufacturing and R&D groups in PharmaCo generate political support project and receptive context for learning transfer* Personal networks with groups outside firm: *networking among project team and external communities (e.g. doctors, hospitals) at PharmaCo legitimates relevance of learning from project to other groups; project team at SocialSer belong to wider consortium in East Midlands;*	**Networking:** Lack of organisational control and co-ordination in network relationships: *Numerous fragmented, weakly linked, continuously changing project groups in TelecomCo make 'know-who' difficult to sustain* Reliance on old networks constrains information search or development of new networks for exchange of learning: *Strength of ties among group of REMs in ConstructionCo limits new entrants and scope of knowledge search and transfer by network members*
Learning Capture Information for others provided in timely and relevant manner: *relevant project documentation at SocialSer; Central information co-ordinator to provide tailored documented information and fast feedback to inquiries at PharmaCo* Visible measures of project performance to provide feedback and legitimate project learning to wider organisation: *Percentage cut in waiting lists in Health* Celebrating successes - to create a copying/ modeling effect: *success stories published via internal newsletters and PR campaign in PharmaCo; Improvement in survival rates for prostrate cancer patients in PharmaCo* Capture of failures: *Mistakes made in US project (learned through personal networks) helps more strategic development of related projects in PharmaCo Europe*. Information technology: *Intranet provided standard documentation and procedures in SocialSer; Internet used to widely communicate project learning to outside communities in PharmaCo*	**Learning Capture** Information not provided to other groups in relevant or timely manner: *information captured in intranet at ConstructionCo incomplete, redundant or irrelevant due to inherent unpredictability of information requirements, lack of incentives for keeping information updated, problems of codification; Archives (project reports) in TelecomCo unwieldy to access and include much irrelevant material* Information technology: *Email displaces social contact needed to generate trust and share tacit knowledge at ConstructionCo; email lists generate information overload at TelecomCo; lack of standardisation of IT and access problems make them difficult to use at PharmaCo and ConstructionCo* Lack of visible measures of successful output from project learning: *Success in TelecomCo measured in terms of application to market rather than generation of new ideas/ learning from projects; Lack of proven financial gains from REM project to convince sceptics in wider organisation of learning outputs in ConstructionCo.*
Organisational Context Integrated structure: *Centralised structure at SocialSer enforces information sharing across organisation (vertically and horizontally); Location of change project within one group (engineering) at ConstructionCo aligns project with overall organisational structures and rewards* Political climate: *top management support at HealthSer via*	**Organisational context** Differentiated/decentralised structure: *Weakly connected business areas at TelecomCo; regional boundaries at ConstructionCo and HealthSer; decentralised structure at PharmaCo fails to support learning from being supported and transferred* Established hierarchies/functional silos: *Cross functional projects operate outside mainstream structures posing problems for*

transformation team; Project Leader at PharmaCo enrols support of key senior executive through strategically-focused personal networks; drive from centre to support REM projects at ConstructionCo Culture: *Value placed on quality, scientific advance, patient care and safety in PharmaCo and Health encourages learning across different professional disciplines & functional groups; Value on bottom-line results through reducing wasteful reinvention enhances legitimacy of project learning at ConstructionCo*	*recognition/capture of project learning* Restructuring: *Restructuring at TelecomCo creates 'internal boundaries' and conflicts that limit knowledge sharing; constant restructuring at PharmaCo creates uncertainty about senior positions and overall strategy making 'value' of projects difficult to assess* Political climate: *Lack of senior management support for, and co-ordination of, cross-project learning at TelecomCo and ConstructionCo; Political infighting generates difficulties in gaining commitment to project learning at PharmaCo; Political uncertainty at TelecomCo leads individuals to focus on own projects and career development*

4.2. Analysis

4.2.1. Project characteristics

Central to the development of our analysis was the distinction between projects aimed at product innovations (i.e. the development of new products or services) and process innovations (the development of new management and work/organisational practices). Existing research on project-based learning tends to focus on product innovation (Tidd, 1995). A significant feature of our study was that all projects involved significant degrees of process innovation (even where the delivery of new services were part of the project, as in the PharmaCo and HealthSer cases). This process innovation posed unique problems for knowledge capture and transfer. Learning in product innovation projects tends to follow a convergent path - diverse sources of knowledge are progressively integrated within a single product or service specification. Learning can therefore be captured and transferred in explicit forms (e.g. as product design templates). In contrast what was learned in these process innovation projects was often tacit, intangible and context-dependent (e.g. changes in work practices, roles and responsibilities, attitudes and cultural values) and therefore difficult to capture in explicit forms, at least in ways that could be understood and applied in new contexts. Social and behavioural processes were therefore found to be more important to the capture and transfer of knowledge in these projects than knowledge management practices (e.g. the use of ICTs) aimed at the codification of knowledge. This mirrors Hansen et al's (1999) research that found that personalisation strategies (involving the development of personal social networks) were more effective than codification strategies where the knowledge to be transferred was largely tacit in nature. Thus our analysis focuses specifically on project learning capture for process innovations - an area that has been neglected in previous work but which is critical to the development of firms' innovative capability (Clark and Staunton, 1989).

Another key characteristic of these projects was that, despite sectoral differences, multidisciplinarity and cross-functional expertise in projects was the norm. This applied even in sectors where projects might be expected to incorporate a narrower range of expertise (e.g. pharmaceuticals). This suggests that mechanisms for managing knowledge in multidisciplinary projects should be an integral feature of a framework guiding future work, especially given that many firms find cross-functional knowledge sharing particularly problematic (Clark and Fujimoto, 1989). Although we had expected the time-scale of projects to be an important defining characteristic (Clark, 1985), this was not a significant factor in our study. However, this may reflect the short time-scale over which the research was conducted and the relatively long, and in some cases practically open ended, life cycle of the projects studied. This said, the size and scope of the project was relevant. Projects involving the capture and

transfer of knowledge across groups that were spread across regions or nations (e.g. ConstructionCo, PharmaCo) typically posed more challenges for cross project learning and knowledge management than those at single locations (e.g. PublicSer).

All together, the key elements of the project characteristics can be identified as follows:

- **The tangible scope of the project**, especially in terms of its physical or geographical dispersion
- **The tangible nature of innovation** as to whether the innovation was predominantly process or product-driven

4.2.2. Project process characteristics

As suggested, behavioural features of project working and project management had major effects (potentially both as enablers and barriers) on the capture of learning and knowledge transfer. These are represented in our framework as project process characteristics. A critical feature here was the development of a shared language and ideology around projects. In particular, enforcing a standardised approach to the management of projects and a shared language allowed project lessons to be shared more widely. This reflects Cohen and Levinthal's (1990) observation that to effectively share knowledge firms require appropriate levels of 'absorptive capacity' - the ability to recognise the value of new knowledge, assimilate it with existing knowledge, and apply it to commercial ends. Our study suggested that developing absorptive capacity in the context of process innovation creates particular challenges. Achieving shared understandings across the different professional/functional groups seemed to be the result of not only the development of an appropriate organisational context for the project, but also the shared involvement in the social process through which learning was generated. Abstracting learning outcomes from these key elements of the project experience seemed to be problematic in that respect. This highlights the importance of developing the absorptive capacity of the organisation - its ability to assimilate new learning - as much as the transfer of learning per se. Our findings suggest, then, that project learning capture for this type of project depends as much on transferring elements of the context and social process which creates the learning outcomes as on transferring the outcomes themselves.

Accordingly, the key elements of the project process and context can be identified as follows:

- **Appropriate incentives and motivation**: incentive structures are important in the individual's willingness to share or exploit knowledge (Scarbrough and Carter, 2000; Keegan 1998);
- **Adequate resources**: including training and education, time and management capability are important contextual features which help to influence the likelihood of learning being effectively captured and transferred (cf. Cyert and March's (1963) notion of 'organisational slack');
- **Appropriate breadth and depth of skills and expertise**: this encompasses the issue of redundancy (i.e. knowledge overlap) and requisite variety which are also identified as important features of the 'knowledge spiral' by Nonaka (1994).

The social process through which learning was generated could thus be characterised according to three key variables:

- **The development of shared languages/ideologies as well as trust and norms** for knowledge sharing emerged through informal interactions between groups (Ring and Van de Ven, 1994) and in particular in the experience of collaborative working on a shared problems (Cole, 1999);
- **The emergence of a committed project champion** (Ginzberg and Abrahamson, 1991) was important in terms of the sense-making process within the project. Such champions were important in terms of celebrating success and thereby catalysing learning from a complex and uncertain situation;
- **Linking pin/boundary-spanning individuals or 'internal knowledge brokers' were** important in translating the experience of the project team into the language of the wider organisation (Brown and Duguid, 1998; Grandori and Soda, 1995).

4.2.3. Networking/Communication

Networking and communication within and across teams are crucial in process innovation projects that, by definition, cut across existing processes and organisational routines. Each project team brings together a range of personal networks linking the project to the rest of the organisation and to information sources outside the organisation. The configuration and quality of these networks helps to influence the kinds of knowledge which the project team is able to draw on and the ability to transfer this knowledge to other groups. Our study confirms the importance of strong network ties for the sharing of tacit knowledge, and of non-redundant weak ties for accessing explicit knowledge in other parts of the organisation (cf. Hansen, 1999). At the same time, the value of personal networks also had to be balanced against the possible limiting effect of strong or redundant ties on information flows.

Key elements of the project process of accessing and sharing knowledge were dependent on

- **The use of networks within or outside the organisation** that generates political support and/or help sustain receptivity and access to appropriate resources;
- **The level of control over and co-ordination in network relationships** that legitimates inward/outward learning relevance and span.

4.2.4. Knowledge Transfer and Learning Capture

Knowledge transfer related to the extent to which these re-usable products of project learning were made available to and applied by other project teams and the wider organisation. To a significant extent, the tacit elements of project learning were transferred as embodied knowledge (Blackler, 1995) through movements of personnel between project teams. As such movements also impact on personal networks, this suggested that staff rotation between project teams is a key element of inter-project knowledge transfer. More generally, personal networks have a two-fold importance in relation to knowledge transfer; first, in identifying and accessing the necessary knowledge to develop the project; second, enhancing the informal transfer of project learning by helping to develop the relationships and trust that underpin it. Knowledge transfer also took place in our study via the transfer of documentation and through electronic means (Intranet and email). However, our study suggested that information technology systems may link geographically diverse teams but may inhibit knowledge transfer if it becomes a substitute for face-to-face interaction (Anderson, 2000).

Directly linked to the issue of knowledge transfer were those of learning capture. A number of factors were seen as influencing the effective capture of learning. An important issue here was the extent to which learning was captured within organisational memory. While the development of product innovations is well recorded through various design iterations and artefacts, process innovation is less likely to leave such a trail and more likely to generate tacit or procedural knowledge. Noting the limitations on the codification of such knowledge outlined above, the role of information technology and formal documentation in capturing learning was relatively constrained in our study.

Key elements of the outcome of knowledge were dependent on learning capture capability aspects:

- **The ability to identify or envision parallel problems/opportunities** that corresponded with personal experience;
- **The representation of project experience as stories** of either success or failure which could be related by analogy to other parts of the organisation, and
- **The incorporation of learning in new process designs and routines**, which could be copied or adapted in other areas.

4.2.5. Organisational Context

A number of studies have highlighted the importance of the wider organisational context for the capture and dissemination of knowledge and learning (e.g. Kogut and Zander, 1992). In terms of the broad variables of organisation structure and culture our study found that in bureaucratic contexts, multidisciplinary projects encountered problems of capturing and transferring learning across internal boundaries. While role cultures are seen as effective in capturing process improvements (Adler and Cole, 1993), they were more hostile to multi-disciplinary ventures. It was also important to address the way in which these organisational features interacted with other factors including business strategy and the financial control system. For example, the time-horizons of management objectives exerted a strong influence on the willingness of project teams to capture learning and share knowledge across internal boundaries. While the structural/cultural backdrop was a pervasive but diffuse influence on project working, a more immediate influence came from the specifics of the interface between the project and its context. In particular, the physical co-location/distribution of organisational members was especially important in terms of knowledge transfer since this was seen to affect the personal networks of individual team members and their interaction with members of other parts of the organisation/project teams (cf. Edelman, 2000).

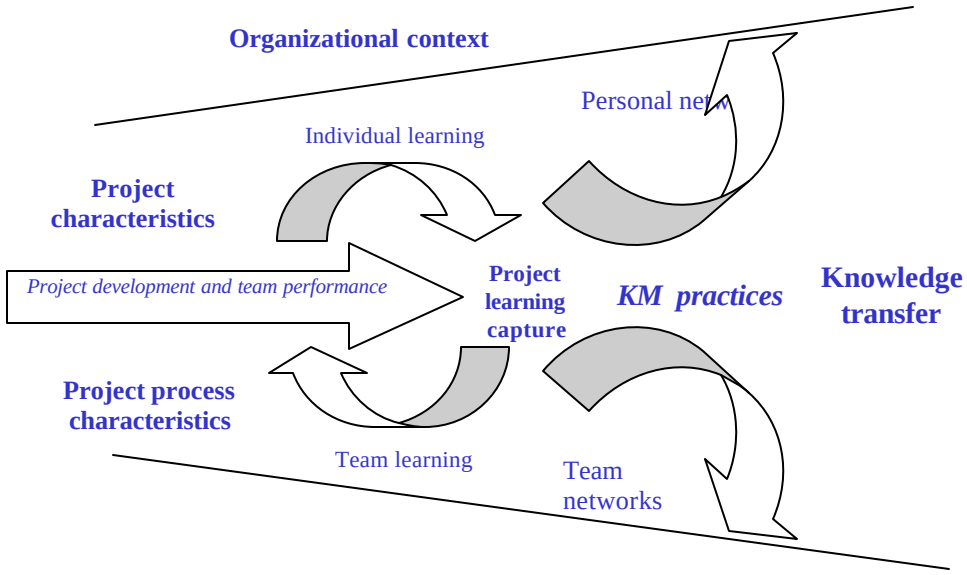
Key elements of the organisational context were

- **The degree of structural centralisation and integration**, in particular the role of location and ownership of projects and their alignment with the overall organisational structure;
- **The political climate** and top management commitment, support and drive;
- **The organisational culture(s)** and the differences between professional groups and organisational divisions, especially in terms of established hierarchies and functional silos.

4.2.7 Toward a framework of project-based learning

These different dimensions of the study demonstrate the holistic approach that was taken to the capture of project learning. The analysis of such relationships involves a process model which highlights the interactions between project development and learning over time. By focussing on process innovations, the study posits a number of important relationships between the key dimensions outlined above which evolve recursively over the course of the project. In particular, it addresses the influence of organisational context, project characteristics and the way the project is conducted (i.e. 'project process' encompassing the role of individual project champions, team performance and boundary-spanning roles) on the learning generated at the level of the project team. It further relates the capture and transfer of such learning to the mediating role of processes for knowledge management and the distributive effect of personal and project-team networks within the organisation. Finally, knowledge transfer to other projects and the wider organisation is seen as an emergent outcome of these interactions. These dimensions are pictured in Figure 1 below.

Figure 1: **Toward a framework of project-based learning**



5. Implications and conclusions

A core prescription from the knowledge management literature is that the successful management of organisational knowledge will prevent firms from 'reinventing the wheel', in particular through the transfer of 'best practices' across projects. The findings of the comprehensive and in-depth analysis of factors enabling and inhibiting knowledge management in project work of our research conducted across a range of industrial sectors in the UK clearly challenge this logic.

In particular, this comparison suggests that many features of project-based practices and learning pose specific challenges to current knowledge management and project management approaches. In particular, the capture of learning from such projects is inherently more difficult than many other areas of knowledge management practice simply because project-based work tends to lack the institutionalised mechanisms for knowledge capture,

learning and improvement, which are built into more steady-state activities (Edelman, 2000). Also, to the extent that they are typically multidisciplinary and cross-functional, such projects are likely to encounter functional barriers to knowledge sharing (Knights and Willmott, 1998; Westbrook, 1991; Newell et al., 2001), both *within* and *across* project-based work.

Findings also suggest that these barriers are related not so much to the use of specific tools to codify tacit knowledge which has traditionally been a focus of much knowledge management work and research, but to organisational and behavioural constraints which inhibited the effective use of knowledge management tools and prevented lessons being learned from projects or being made available to other groups. These features of project-based learning pose a major challenge to current knowledge management and project management approaches.

They suggest instead that knowledge is emergent and enacted in practice, and that normally those involved in a given practice have only a partial understanding of the overall practice. Generating knowledge about current practice is therefore a precursor to absorbing relevant learning and changing that practice. In this sense, knowledge transfer does not occur independently of or in sequence to knowledge generation, but instead the process of knowledge generation and its transfer across projects are inexorably intertwined. Thus, rather than transferring 'product' knowledge about the new 'best practice' per se, our analysis suggests that it is more useful to transfer 'process' knowledge about effective ways to generate the knowledge of existing practice.

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