Developing Communities of Practice for International Construction Organizations[1]

Dr. Thomas Grisham
St. Petersburg College, Grisham Consulting Inc.
4550 Plaza Way, St. Pete Beach, FL, 33706 USA
Phone - 727.363.7036, Email: tgrisham@tampabay.rr.com

Dr. Derek H.T. Walker
School of Property, Construction and Project Management, RMIT University,
Melbourne VIC 3000 Australia.
Phone: 61-03-9925-3908, Email: derek.walker@rmit.edu.au

Introduction

This chapter offers ways to develop and cultivate effective knowledge transfer through building and nurturing global construction communities of practice (CoPs). A reflective learning study identified the need for organizations undertaking construction-engineering projects to nurture a knowledge environment through developing CoPs. The study was specifically focused upon three complex global projects. Conclusions are supported by a UK case study and also a recent study of knowledge management practices of three large global Australian construction contractors. The key theme that emerged from the study is the need for learning to be enhanced within and across projects and in turn, for facilitating project teams to provide feedback knowledge to their host organization. Reference to other industries that are seriously developing CoPs as a knowledge management (KM) tool and a trigger for innovation lends additional support for the presented model and metaphor of knowledge transfer.

First, we need to think about the nature of the firm and its *raison d'être* to justify our focus on knowledge as a key organizational asset. The resource based view (RBV) of the firm has been steadily challenged. The RBV regards an organization as a collection of resources (objects) deployed to accomplish business (or organizational) goals (Grant, 1991). Firms are now increasingly being analysed from a knowledge-based view (KBV) of the firm. This perspective holds that organizational success is better explained through the way that knowledge is deployed by its people to achieve the organization's aims—thus making knowledge a key resource (Grant, 1996). Further, a dynamic capabilities view (DCV) of the firm has emerged from this KBV view to make sense of exactly how resources and knowledge are applied in uncertain, turbulent, complex, and volatile situations. This view holds that business success results from the innovative way that resources, particularly knowledge, are marshalled to rapidly respond to complexity (Spender, 1996; Teece, Pisano and Shuen, 1997; Eisenhardt and Martin, 2000; López, 2005). All three views of the firm stress knowledge, and an organization's capacity to learn and apply learning, as being pivotal to business success. Knowledge does not exist as an independent entity, it resides in the minds of people in the organization (Skyrme, 1999; Snowden, 2002). Further, as Snowden argues (2002: p102), knowledge is a complex

[1] This chapter substantially expands upon Grisham, T. and Walker, D. H. T. (2006). "Nurturing a knowledge environment for international construction organizations through communities of practice " *Construction Innovation: Information, Process, Management* **6** (4): 217-231.

abstraction of data and information that is refined as a highly contextualized abstraction. The rapid communication of ideas and arguments that supports decision making for example, is highly value laden and reflects cultural embeddedness, shared experience and understanding of the context of salient issues. The cost of sharing abstract knowledge includes developing shared mindsets and culture to translate languages/ symbolic representations that allow meaning to be effectively shared. The payoff for this effort is a rapid transfer of understanding of the meaning of data and information, and from that a capacity for dynamic capabilities of effective decision making and coordination of subsequent action (Snowden, 2002).

Therefore, we can see that organizations need to develop dynamic capabilities that are enmeshed with the creation and maintenance of a knowledge environment. Thus, it is vital for project management teams to advance project management effectiveness through using tools that help them share knowledge and dynamically adapt and use that knowledge.

One tool for knowledge management that has been offered is the CoP. A CoP is defined as "groups of people informally bound together by shared expertise and passion for a joint enterprise" (Wenger and Snyder, 2000). There has been increasing interest in the concept of CoPs in relation to the construction industry, for example see Peansupap and Walker (2005a), Fernie *et al* (2003) and Jewell and Walker (2005). CoPs are being recognized as a strategic asset that needs nurturing (Storck and Hill, 2000). To achieve this, organizations need to create a knowledge environment that supports CoPs and their knowledge creation, transfer, and use activities. Further, supporting technology and processes needs to be put in place to nurture CoPs (Walker, 2005). Knowledge management (KM) can be seen as the management of knowledge stocks and flows in a dynamic environment (Bontis, Crossan and Hulland, 2002) and so a metaphor that facilitates the visualization of this process could be useful. This chapter presents a metaphor of KM as a pipes-and-valves system to describe the knowledge flow process, together with theoretical and actual examples of CoPs.

The chapter is structured as follows. First the relevant literature is reviewed. Drivers of CoP creation and maintenance and supporting techniques to develop and sustain CoPs are then discussed using actual examples and then concluding comments are offered.

Supporting Theory

The Importance of Creating a Knowledge Environment

A knowledge environment provides the foundation for a learning organization to discover, share, and create knowledge. For a knowledge environment to exist, the management of the firm must demonstrate leadership by inculcating trust, empathy (caring), power allocation, and effective communications (von Krough, 1998; von Krough, Ichijo and Takeuchi, 2000; Grisham, 2006). This can be effectively achieved through CoPs associated with the firm. A knowledge environment thus nurtures a special feel or sense of a place where knowledge is valued, appreciated, and effectively deployed. Nonaka and Konno (1998) use the Japanese word *ba* to describe an environment where knowledge work is undertaken as part of normal business. They describe *ba* as an ecological/organic process that spirals through the Socialization, Externalization, Combination and Internalization (SECI) cycle.

In the *Socialization* phase of the SECI cycle, tacit knowledge is shared and exchanged. However, explicit knowledge often does not have an accompanying explanation of the

context of that knowledge. While explicit knowledge may be conveniently available, it is of less value than sound tacit knowledge because tacit knowledge embeds context. The output from this process *externalization*, involves turning value-added tacit knowledge into an explicit form—this includes documentation, explanation or recording the cumulative experience of the situation under consideration. This allows knowledge *combination* to occur where new knowledge is combined with existing knowledge stocks to make the result explicit. This also leads to people *internalizing* the knowledge whereby they experiment and then reshape in their mind how this knowledge is of use and how it can be usefully deployed. Essentially the SECI model is a learning model as well as a knowledge creation model and the cycle continues in a spiral rather than a circular mode. The effectiveness of the knowledge environment will be determined by the degree and consistency of the leadership and supporting human interaction infrastructures.

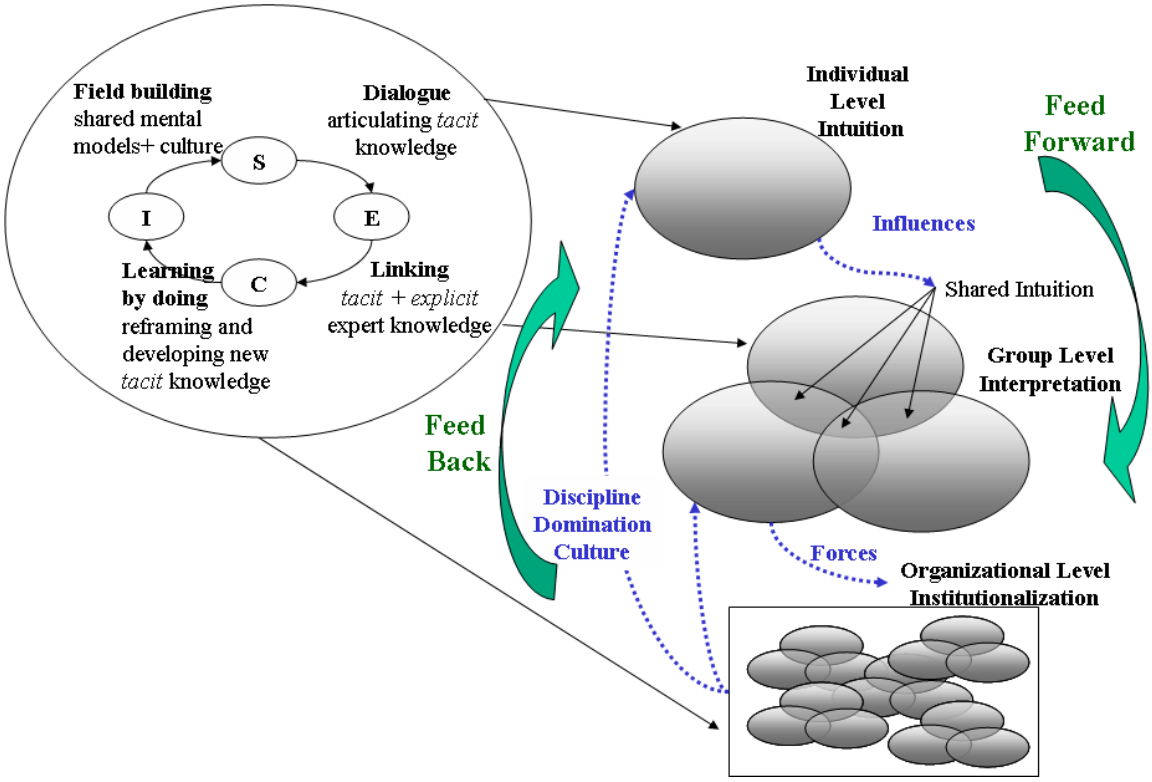


Figure 1 - Knowledge Transfer Model and the Role of Power and Influence

Figure 1 illustrates the SECI model (Nonaka and Takeuchi, 1995) as it affects groups and organizations. This model is adapted from ideas proposed by Crossan, Lane and White (1999) and then further developed by Lawrence, Mauws Dyck and Kleysen (2005).

Crossan *et al*. (1999) developed the 4 I's concept to view knowledge exchange in a three level framework, with knowledge flowing forward from individuals to groups and to the entire organization and at each stage feeding back. They describe four processes taking place: *intuition, interpretation, integrated,* and *institutionalized*. Individuals' knowledge, experience and interpretation of context are internalized as *intuition* and these are communicated as metaphors to abstract this knowledge in its context. This is *interpreted* by individuals when the socialize in groups to exchange meanings and re-frame their intuitive knowledge adding perceptions of others in this re-framing process using cognitive maps, language and dialogue. This interpretation process moves from dyads and small groups to larger groups then the entire organization. In the interpretation process shared meanings are *integrated* using interactive mechanisms with mutual adjustments of shades of meaning to arrive at shared understandings (never exact

but within closer ranges of interpretation). These shared mental models become *institutionalized* and formalized into procedures (explicit and tacit), rules and regulations and routines that the entire organization then accesses and adapts as its organizational culture.

Lawrence, Mauws Dyck and Kleysen (2005) developed this idea further to explain how power plays its part in this process that is highly relevant to our chapter. They argue that individuals influence groups. Once groups have accepted knowledge as valid they then force the organization (through a process of reason, routines and emerging culture) to accept the meaning and understanding of knowledge used as being valid and useful. This then creates cultural validity, and provides the discipline and dominant world view that is expressed as the accepted organizational cultural "truth" or approach to decision making for example. Knowledge transfer and behavior under this model is triggered by a feed forward and feed back dynamic that self-adjusts to the reality of the context in which this organization is perceived by its members to be operating. This dynamic flow facilitates the dynamic capabilities described by Teece *et al*. (1997). The perspective of how a nurtured knowledge environment affects the way that an organization behaves is particularly powerful in explaining how CoPs can be far more effective in facilitating dynamic capabilities than the leadership of an organization directing by fiat how knowledge should be best transferred, and how sound decision making should take place.

A knowledge environment in a global business should have a passion for creating, transferring, and using knowledge generated through and with the project supply chain (including the customer) that spans national boundaries. Further, the call for flexibility and rapid adaptability lies at the core of a decade of business literature (Kanter, 1989; Teece *et al.*, 1997; Eisenhardt and Martin, 2000).

Firms need strong leadership (trust, power, empathy, and communications) to create and manage a knowledge environment. A system that helps the feed forward feed back of knowledge in a freely flowing manner can enhance this trust as such knowledge is owned by participants in this process (Lawrence *et al.*, 2005). Also, to create and nurture a knowledge environment, business leaders need to demonstrate the importance of knowledge to the business, and to instil the pursuit and sharing of knowledge as a passion into everyone in the firm. In addition, they must allow time for people to share their knowledge (von Krough *et al.*, 2000).

In a well referenced paper on temporary organizations Grabher concludes (2004: p211) that: "the formation and operation of projects essentially relies on a societal infrastructure which is built on involving a diverse range of collaborators, roles and straightforward substitution but have to be regarded in terms of interdependence. 'Cool' projects, indeed, rely on 'boring' institutions." Grabhner's idea is to use the 'boring' institutional long-term relationship to build trust in a short-term (transactional) organization—in this chapter the construction project organization, or temporary project organization (TPO) (Winter, Smith, Morris and Cicmil, 2006; Grisham and Srinivasan, 2007a).

The CoP Concept

The concept of CoPs is not new. Etienne Wenger defines a community of practice (CoP) as "groups of people informally bound together by shared expertise and passion for a joint enterprise" (Wenger and Snyder, 2000, p139). However, Wenger and others have described how organisations can encourage and support a CoP. A CoP shares knowledge and skills and sustains its members through obligation to exchange knowledge, providing access and accessibility to shared insights and knowledge about the practice of work

(Wenger, McDermott and Snyder, 2002, p4). Lave and Wenger (1991) describe CoPs in terms of situated learning and draw upon diverse examples from tailors in India to United States (US) corporations. This concept is rooted in groups of people sharing stories/ parables as a means of transferring tacit knowledge and making sense of situations. Nishida (1958) said of Zen thinking that "one cannot grasp life by learning and knowing, but only by practicing". Wenger (1999) echoed this idea saying that knowledge is a matter of participating. Lave and Wenger (1991) argue that knowledge and practice cannot be separated in the transfer of knowledge between individuals. Therefore, effective CoPs will find root where groups of people share common interests and/or responsibilities. Hildreth *et al* (2000) cite observations made by Brown and Duguid (1991) that CoP members share a common sense of purpose and a need to know what other members know.

Sense (2003; 2005) also discusses the important political and cultural dynamics at work in situated learning situations, and posits a model that envisages an external environment that has its own dynamic of current and emerging power manifestations impacting upon project leaders, and indeed any group trying to transfer knowledge within an organization. The internal environment of the group entity (be that workgroup, organization or CoP) also has current and emerging political influences that adds to the dynamic of the learning outcome. A project leader or those within a CoP that try to shape it chooses to apply a political approach between accommodating or direct influencing. At the influencing end of a scale using a formal approach, Sense (2003: p110) sees purposeful learning taking place that could be facilitated reflective learning or some kind of structured activity. When informal influence is applied it has great emergent characteristics resulting in networked learning. An informal accommodating leadership style can result in opportunistic learning such as is seen in CoPs where a discussion thread may seem to have a life of its own. A more formal accommodating influencing style will be expected to result in what Sense (2003: p110) refers to as adaptive learning.

The way that CoPs develop can be understood through the nature of power used by members. Members have the capacity and ability to shape and influence, and to set agendas and priorities for discussion and learning. CoPs can be *ad hoc* and emergent, developing out of an organic need for people to share knowledge and insights, or they can be facilitated by organizations or indeed designed and established by organizations to suit particular purposes. Peansupap (2004) and Peansupap and Walker (2005a) show how three global construction organisations used a CoP approach to effectively diffuse knowledge about an information communication technology (ICT) groupware application. Peansupap and Walker (2006: p375) also illustrate drivers and constraints that affect groups of people in a CoP sponsored by an organization to enhance ICT diffusion through knowledge exchange. A key finding of that study was the need for solid organizational support in building and facilitating a knowledge network, through technology and physical interaction, for key players to link members of the groups together to share exchange and reframe knowledge as illustrated in the Figure 1 process.

Hildreth *et al* (2000) found in their studies that in distributed environments (global firms for example) the need for face-to-face meetings was important to maintain group cohesiveness. Also, regular electronic communications was used to refresh contacts. Wenger (1999) observed that there are two reasons why CoPs have not become prevalent —they are not easy to build, and that nurturing them requires substantial effort. However, since CoPs are organic by nature, they can spring up at times and places that run contrary to a firm's goals and objectives. An organization cannot directly dictate the structure and processes that define a CoP. Brown and Duguid (1991) state that communities are emergent from the process of an activity, and that a key issue for

organizations is the detection and support for communities. According to Hildreth *et al* (2000), CoPs are formed by informal contact between members, and people who are doing similar work – CoPs have a common set of interests and are self motivated, not directed. Storck and Hill (2000), however, present a case where Xerox corporation effectively established and nourished a CoP to help it diffuse information technology (IT) through an alliance, as well as citing other examples of corporate sponsored CoPs—nevertheless, they stress the relationship between the sponsored CoP and its members is one of being a supportive facilitator rather than a controller.

A number of construction companies around the world have established CoPs, and many use software tools such as a form of 'yellow pages' that identifies experts who can be contacted to answer specific technical questions. For example, Peansupap and Walker (2005a) indicate how three major Australian contractors with global projects underway use CoPs across the organization for technical knowledge support, but also within project organizations for more local problem solving activities.

Jewell and Walker (2005) provide a case study of the United Kingdom (UK) contractor Carillion Plc using a software tool Sigma Connect^{tm} in another example of CoPs that support nurturing an knowledge environment that links people with expertise at a number of levels. Sigma Connect^{tm} was conceived in late 1996 within the Shared Petro-technical Resource of British Petroleum (BP), where it was known as 'Connect'. The original desire was to create an expertise-based directory to promote closer working relationships between some 500 exploration consultants and their clients in the business units. The initiative sought to move away from the classical texturally oriented approach, and build a more informal solution in the form of an Intranet based web site. On completion of an initial pilot phase, 'Connect' was taken under the stewardship of the KM community within BP enabling its use to be extended throughout BP with Addept Computer Services, responsible for the on-going development of the system which evolved throughout 1997 and 1998 as participation increased.

It is interesting to note that in mid 1998 'Connect' was adopted as a strategic tool for the merger between BP and the American Oil Company (Amoco). It proved invaluable in assisting the integration of people from the two corporate backgrounds. In addition to the proven support as an expertise system, functionality was added to support the management of CoPs within the organization. Sigma Connect^{tm} was first piloted within Schal, a subsidiary of Carillion, which provides fee based construction management and consultancy services. A key factor in this business was getting the right people with the right experience involved in each project; process innovation often being the differentiator between competing project bid proposals. Carillion viewed Sigma Connect^{tm} as an essential part of the knowledge management jigsaw puzzle. It is not a solution in its own right but plays an important role along with what they term their 'Knowledge Forum', the 'Knowledge and Innovation network' and 'Best Practice Programmes' many of which are substantiated by a CoP within Sigma Connect^{tm}. Carillion have created a number of different CoPs within Sigma Connect^{tm}. These range from the purely social groupings like a five-a-side football tournament, through the typical expertise based CoPs focused on the use of other ICT products, to a highly structured CoP to support the implementation of their internal Fast Track Management Programme (Jewell and Walker, 2005). This illustrates a decade long history of application of the CoP concept.

There are a growing number of contractors now deploying CoPs. In an Italian study, Gherardi and Nicolini (2002) considered the ways that CoPs interact – focusing on the perspectives of foremen, designers, contractors on safety. They found that discussions

typically included discourse in practice, and discourse on practice (i.e. what happened and why it happened). So we see how CoPs can be used as an effective tool to nurture a knowledge sharing environment.

Research Method and Approach

The approach used for research work reported upon in this chapter is primarily reflective practice based upon considerable experience in complex global construction projects. Reflective practice (Schön, 1983) has a long established acceptance in the management literature as a valid research methodology. Its original roots lie in action learning through change management (Lewin, 1947) and sensemaking, literally contemplating and reflection upon action in order to make logical sense out of events (Weick, 1995;2001). This approach has facilitated more formal research methods revolving around reflective practice, either as passive observer or more active participant in change cycles (Coghlan and Brannick, 2005), or being more intimately involved in the process through experiential learning. Coghlan and Brannick (2005) present a model of experiential learning as experiencing something, reflecting upon that experience, interpreting and making sense of what was experienced and taking action based on the interpretation. This process can be repeated for planning an action, taking the action, evaluating the action, diagnosing the evaluation in order to repeat the process. It is perfectly permissible to be a full participant in such a study (Coghlan, 2001). Sense (2005) in a recent project management study, was involved in very close contact with, and interacted with others participating in a knowledge transfer change initiative.

Data gathering sources for such studies vary. Much of the data can be gathered as observations, unstructured interviews, frequent casual and short dialogue with participants, and access to documentary data such as minutes of meetings, company procedures and project documentation sources (Sense, 2005). Much of the data for this chapter was drawn from informal sources and dialogue that makes tacit knowledge explicit. The major danger to validity of this type of data is that it is subject to bias and misinterpretation, and so numerous different sources need to be accessed to ensure that triangulation of data occurs, as well as careful clarification of interpretations made by the researcher to interviewees offering that data.

The principal researcher undertaking the study reported upon here has been intimately involved in project management roles in many countries on complex major engineering construction projects for over 35 years. The nature of the complexity included working in locations where the political and social environment was underdeveloped (compared to so-called western economies), thus much of the knowledge required to get tasks done needed a lot of local contextual knowledge. Three case studies were chosen from the principal researcher's international contracting emersion experience to illustrate the nature of problems studied. These case studies, described below, are representative of the knowledge transfer challenges experienced between teams from mixed culture backgrounds where this researcher participated in solving practical problems. Field notes of observations, data from informal interviews with project participants and access to more formal data from project documents were used for analysis. Themes and conclusions were subsequently validated with colleagues and formed the basis of discussions through mentoring and coaching activities, so that while details were not specifically validated, themes and conclusions were. Thus the data represents a distillation of both explicit and tacit knowledge.

The first case was a US$150 million Saudi Arabian power facility. This project had a

project structure similar to Figure 1 (see section 4.1 below). In this case Company A was a consultant firm similar to a project manager or a construction manager, and Company B was a consortium of two companies. The second case was a US$500 million power project in Thailand with a similar project structure, but where the customer performed the work. The third case was a US$1.2 billion power project in India with the customer (in this case the end user a consortium of three companies and a government agency) having Company A as the project manager, Company B was a consortium of three companies, and Company C was a development bank. Each project had a team on the project site and remote-location virtually interacted with teams in other countries. The virtual aspect of the teams and CoPs will be discussed later in this chapter.

Supporting Techniques for Creating and Sustaining CoPs

This supporting theory section established that organizations that wish to harvest knowledge and innovation must create an environment of trust, empathy, and effective communications. The type of procurement structure chosen will often determine the vibrancy of each, and the attitudes displayed by the customer can further serve to forbid, restrict, hinder, or inconvenience communications. Nonaka and Takeuchi (1995: p71) recognize the role of metaphor as a technique by which tacit knowledge can be shared. Metaphor provides a useful shortcut to packing in a great deal of knowledge into a simple idea. The caveat is that participants in such dialogue need to also share the culture that gives meaning to the metaphor. The following metaphor will mean more to people with engineering backgrounds but we all use hydraulic systems of one sort or another involving pipes and taps and so its utility commands broad appeal.

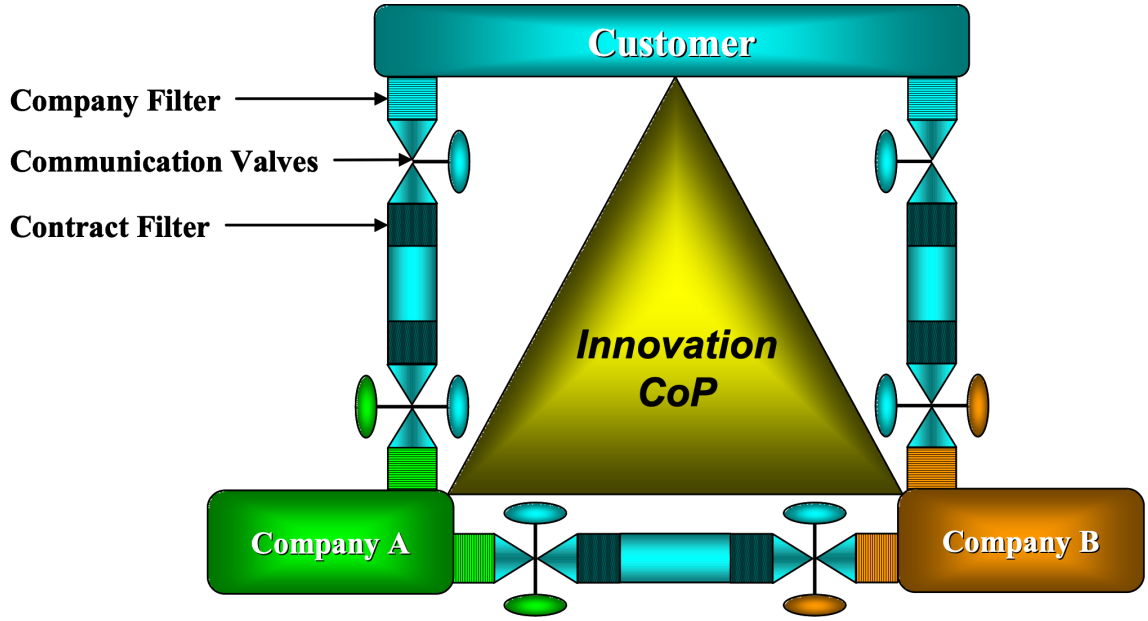
Knowledge Pipelines

It may be useful to visualize how procurement systems can support effective knowledge transfer (flow) using the metaphor of a hydraulic system. Figure 2 depicts a metaphor of knowledge transfer taking place through knowledge flows between contract parties. Thus, it presents knowledge pipelines for a basic procurement structure on a contract that requires two basic types of service in order to complete the project objective.

In this structure there is no contractual relationship between Company A and Company B, but there are contractual agreements between each of them and the Customer. In the construction industry Company A might be the designer and Company B the constructor. In the information technology (IT) industry Company A might be the programmer and Company B the hardware supplier. In more complex procurement structures, Company A might be an end user, and company B might be a consortium, partnership, or alliance of firms. In these more complex structures the Knowledge Pipeline structure is repeated to include more and more valves and filters depending upon the procurement structure existing between the respective companies.

Figure 2 - A Knowledge Pipeline Metaphor

The pipelines (customer to Company A and customer to Company B) that pass information and knowledge are installed by the contract agreement, and described in the general and special conditions. The pipeline (horizontally company A to company B) relies more heavily for definition, of how to transfer knowledge and information between Company A and B to construct the project, after contracts have been awarded. For example, if Company B is a constructor, the contract agreement with the customer might contain



instructions that Company B is to submit payment requests to Company A rather than the customer. Control over decisions for the precise amount to pay, however, resides with the customer. Most contract agreements include general and special conditions. General conditions generically describe how the companies will conduct business (financial, legal, bonding, management techniques, etc.), and the explicitly permitted and implicitly (sometimes explicitly) prohibited communications. Special conditions describe special circumstance for a specific project. For example, special conditions might include specific requirements for implementing a project in Kuala Lumpur. If the same Customer undertook the same project in Johannesburg, the general conditions might be exactly the same, but the special conditions would be specific to the location. Many companies strive to standardize the general conditions so that they can maintain some basic consistency in the business approach, and they then use the special conditions to customize the business policies to the particular location. The general and special conditions describe the procurement structure and the responsibilities of the parties under the contract agreement. Procurement filters are the responsibility of and are created by the customer, and are greatly influenced by the procurement structure selected.

Figure 2 also shows a company filter that is determined by the individual company (customer, designer, contractor, supplier, etc.). The culture of the company can often affect communication that is permitted and encouraged. The company filters also include ethics, market forces, personalities, etc. Some firms are open to improvement and change, others believe that they lead their professions and deserve to be followed; some firms are authoritarian, while others democratic; some firms empower their employees, others discourage personal risk taking; some firms are culturally diverse, others are not. The endless varieties of corporate cultures that exist determine the degree to which communications are actively encouraged or passively discouraged. Issues of profit, risk and power (to mention but a few) also filter information that is shared. Consider the case of a change in scope. If Company A is doing the design and sees that a change will provide a means of correcting an associated design flaw without the other two parties being aware of this, then there could be a desire to withhold this information from the other parties – risk avoidance. If Company B, a contractor, knows that there is one option that reduces their subsequent work, they might likewise push that agenda – increased profit. If both of these ideas were made known, without risk of criticism or retaliation, then an innovative solution may be possible for all of the parties to pursue.

The valves shown in Figure 2 are controls on the information and knowledge that can flow between the parties. The customer to some extent, by reason of the general and special

conditions, can control all valves. Valves can also be controlled by exercise of the customer's power to punish or reward, or by their right to change the contract agreement. However, the companies can also control the respective company valves. For example, Company A is a contractor that may cease providing information to the customer and/or Company B if it feels threatened by an impending lawsuit.

The Figure 2 metaphor serves well to illustrate knowledge flows across companies within a project, but we know that people belong to numerous groups where they have in the past or continue in the present to share knowledge. Many people in engineering construction organizations belong to professional bodies for example. They also maintain contact with colleagues from past projects, and they also will have informal or more formally developed internal knowledge networks. In addition, if the structure of the TPO is such that trust is engendered through a risk allocation process (Grisham and Srinivasan, 2007b), then the TPO can function as a CoP. Remember Wenger and Snyder's definition of a CoP as being, "groups of people informally bound together by shared expertise and passion for a joint enterprise" (2000, p139). This may be the most perfect form of CoP for it is built on the ultimate work group for construction, an integrated project team. It provides the opportunity for other CoP synergies as well.

CoP Synergies

A supporting study referred to in the introduction of this chapter was one undertaken by one of the authors with his PhD candidate (Peansupap, 2004) in which a significant part of the work revolved around study of ICT diffusion within 3 major global Australian based construction engineering contractors. In this study the CoPs investigated and mapped were composed of 21 people that included IT strategists, ICT implementers of the groupware applications that were being rolled out across the organizations, project engineers and site staff from the three organizations (Peansupap, 2004; Peansupap and Walker, 2005a).

Figure 3 illustrates the nature of how CoPs can overlap, and illustrates the rich source of knowledge cross-fertilization that could occur if organizations were more aware of the realities of CoPs that exist but are invisible to these organizations. Three central within-organization CoPs are illustrated. The study of these three Australian organizations indicated that each had an institutionalized CoP with the purpose of rolling out ICT applications. This was supported by a senior IT implementation support person and each supporting project manager/engineer for each organization. These were developed, nurtured, and supported by the organizations, and were well known within that organization. However, members of the CoPs also were affiliated with external CoPs. These external CoPs were either unknown to the three organizations or known to them but not overtly influenced in any way so that agendas, priorities of discussion, and etc. were beyond their scope to influence those CoPs. These are illustrated in Figure 3 as professional institutions (such as the various engineering professional bodies) and networks of past colleagues that shared knowledge even though the membership spanned industry competitors.

By visualizing knowledge transfer as pipelines that could be mapped as illustrated in Figure 3, organizations can be better aware of within-organization as well as external sources of valuable knowledge and indeed access to these knowledge assets through their staff that belong to this variety of CoPs. It becomes evident when we look at the knowledge assets that are available to organizations, their management of this intellectual resource (that can and does provide competitive advantage when applied) is sadly underutilized. This is perhaps due to there not being adequate visualisation tools

and mapping tools, or perhaps because organizations have not seen the nurturing of knowledge through CoPs as being a strategic issue.

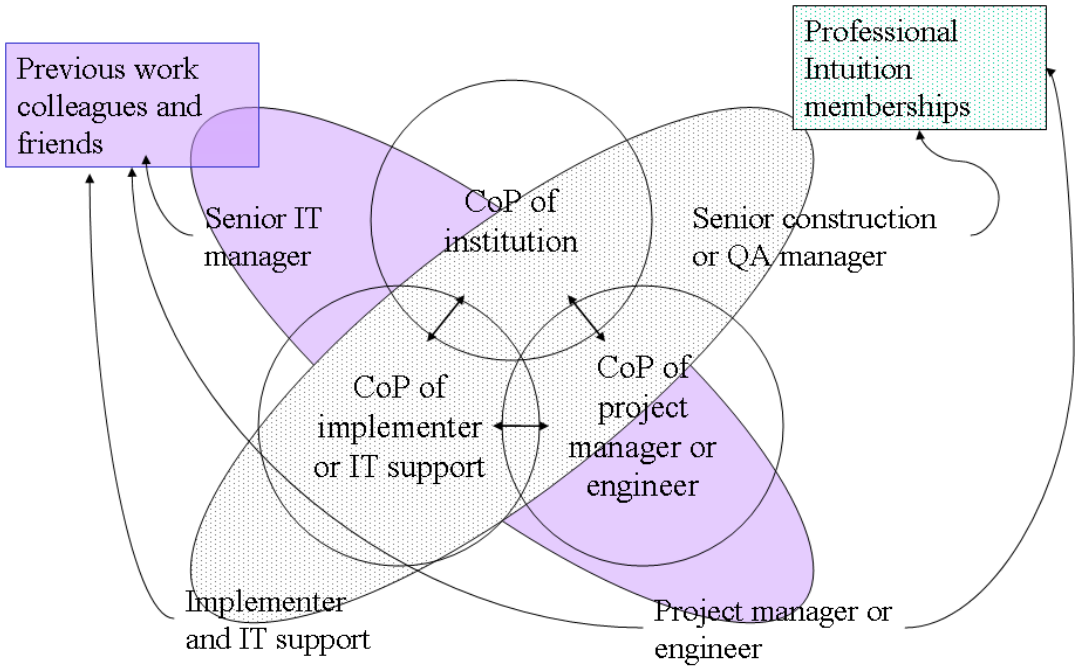


Figure 3 - Interlinking CoPs Affecting Organizations

We will now return to the discussion triggered by the reflective learning study described in the research method and approach section, and discuss how CoPs can be used in practice.

CoP Examples and Possibilities

Using the Knowledge Pipelines, the theory of CoPs, and based upon experience from the three international case study projects as a foundation, techniques that can be used to take advantage of the formation and nurturing of CoPs can now be addressed.

As previously articulated, the published thinking regarding CoPs is that they are generally self-selecting, self-governing groups of people with common goals and interests, and that companies may have a supportive but non-intrusive role in their formation (Wenger *et al.*, 2002). Therefore, CoPs cannot be directly controlled if they are to function effectively. However, as with other facets of project management, there are wide possible ranges of effective practices that can be implemented. A company may encourage the formation of CoPs rather than take an initially passive approach of attempting to identify them. Figure 4 provides a matrix of standard functions on international capital investment projects. Different markets, such as IT, may have different functions, but the model presented could be appropriate to many industries. The three case study projects actually had additional offices in six other countries, but for readability reasons the locations to just two countries have been summarized.

First, there are possible CoPs forming in a co-located single company as is the case with the design functions for Company A (column 1 rows 4, 5, 6 and 7) that are intra-company/ co-located. These CoPs are perhaps the most obvious possibilities for interpersonal interaction is frequent, and in a common language. The three case study projects in fact had multiple offices in the US for the same Company.

#	Company A US Office	Customer US Office	Company B US Office	Company A India Office	Customer A India Office	Company B India Office
	1	2	3	4	5	6
1	CEO	CEO	CEO	Managing Director	Managing Director	Managing Director
2	Project Sponsor	Project Sponsor	Project Sponsor	Project Sponsor	Project Sponsor	Project Sponsor
3	Project Manager	Project Manager	Project Manager	Project Manager	Project Manager	Project Manager
4	Mechanical	Mechanical	Mechanical	Mechanical	Mechanical	Mechanical
5	Electrical	Electrical	Electrical	Electrical	Electrical	Electrical
6	Civil	Civil	Civil	Civil	Civil	Civil
7	Process	Process	Process	Process	Process	Process
8	Procurement	Procurement	Procurement	Procurement	Procurement	Procurement
9	Scheduling	Scheduling	Scheduling	Scheduling	Scheduling	Scheduling
10	Quality	Quality	Quality	Quality	Quality	Quality
11	Cost/Accounting	Cost/Accounting	Cost/Accounting	Cost/Accounting	Cost/Accounting	Cost/Accounting
12	Clerical	Clerical	Clerical	Clerical	Clerical	Clerical
13	Ethnicity	Ethnicity	Ethnicity	Ethnicity	Ethnicity	Ethnicity
14	Avocation	Avocation	Avocation	Avocation	Avocation	Avocation
15	Religion	Religion	Religion	Religion	Religion	Religion

Figure 4 - Possible CoPs for a Hypothetical Global Construction Organization

Second, the Project Manager group (Row 3 for Columns 4, 5 and 6) is a potential CoP formed from co-located multiple companies or inter-company/co-located. These CoPs often form as a matter of necessity due to the remote location from their home offices and the need to develop a local support group. The Electrical Design CoP (Column 3 Row 5, and Column 6 Row 5) is formed around people in the same disciplines, in the same company, but in different locations, or intra-company/virtual. Procurement staff (Column 2 Row 8, and Column 4 Row 8) would form a CoP for people with the same discipline interests but from different inter-company/virtual companies. A CoP made up of Cost/Accounting people (across Row11) in multiple companies and multiple locations presents another possibility.

The third example is where the ethnicity of individuals forms the basis for a CoP (Column 1 Row 13, and Column 6 Row 13). This is similar to the case of the Cost/Accounting people. In all cases the possibility exists of a CoP forming that crosses management levels within a firm.

Information and knowledge sharing that occurs within CoPs is often restricted by the position or power that CoP members have. Clerical people in a CoP would likely be from common power strata, designers from another, project managers from another, and so on. When CoPs form across power strata, there are added dimensions to the information and knowledge sharing—members can see aspects of the project that they otherwise would not have access to. For example, a sponsor may be unaware of the type of problems that a designer may be encountering and similarly the designer may not understand the challenges facing the sponsor. This added dimension offers richness to the communications that is not present when the CoP is from a single power stratum. This model can also be applied to a CoP that consists of an entire project team that spans organizations, ethnicities, countries, and cultures.

To recap, types of CoPs identified above include intra-company/co-located, intra-company/virtual, inter-company/co-located, and inter-company/virtual. Also, a CoP from any of these groups could also cut across the power strata's in the companies. There are infinite possible combinations, and those combinations can be obvious or subtle.

Examples and Illustration of Communities of Practice Needs

The literature suggests that CoPs are self-forming, self-directed, and self-motivating. The literature also suggests that the nature of a CoP encourages team members to trust

one another, and induces their willingness to share information. Companies can, however, encourage the creation of CoPs, and must nurture them after they have formed (Wenger *et al.*, 2002). Procurement structures (the structure of the TPO) influence the possibility of CoPs formation, and determine whether or not they can be nurtured. Five major themes of CoP needs that emerged from analysis of the data that was based upon observation, reflection on experience, and conversations with colleagues over the years are now explored. These are: a knowledge environment; discovery of potential members; information sharing; time to communicate; and project motivation.

Knowledge Environment

For CoPs to form there must first be a knowledge environment – consider CoPs as seeds, and the knowledge environment as fertile ground. Experience has shown that CoPs can form in barren conditions (competitively bid fixed price TPO's) but only when the members are strongly pulled together. For example, on the project in Saudi Arabia an inter-firm/co-located CoP formed around diving in the Red Sea, one of the few physical activities possible in the Kingdom. The group was created as a way to escape from the demands of the project. To use the seed analogy, the CoP formed through stubbornness and survived like weeds growing in concrete pavement. Wenger *et al* (2002) stress that for a knowledge environment to exist it takes a leadership commitment on behalf of all companies involved in the project. This was the case.

CoPs formed on the project in Thailand in a different manner. Staff from each of the companies responsible for receiving materials for the project found that they had a number of practical interests in common. The customer's Thai practitioners were motivated to join the team to learn about cutting-edge procedures and methods. Company A practitioners were interested in maintaining control over the materials needed for construction, and Company B practitioners were motivated to keep control over the spare parts that would be needed during operations. The CoP formed out of mutual dependence and grew into a group that took their lunches together and often met after work to socialize. The CoP was effective and knowledge was transferred between the practitioners. Although there was not a strong knowledge environment, project leadership encouraged the formation of the CoP and nurtured the group's activities.

Discovery of Potential Members

The discovery of potential members of CoPs is the next challenge. Figure 4 indicates that there are certain groups that could naturally form CoPs, for example the electrical engineers. On the project in Thailand, the Thai nationals tended to form their own ethnic group, as did the British and US expatriates. A word of caution is necessary on this point. When people form CoPs from an ethnic, language, political, or religious perspective, it is important to monitor the group. It is possible for a clique to form, or worse still, a group that embraces homogeneity or segregationist leanings. Experience shows these groups are the easiest to form and unfortunately can serve the opposite goals from those of creating a knowledge environment. Nevertheless, such groups can be linked with other groups, and this approach used on the Thai case study project was to synergize linked CoPs—this proved to be very productive for the project.

An initial consideration for the discovery process is simply enabling people on the project to know who the other people on it are, and to learn something about their culture, job, and background. The Indian case study project used a roster of participants that included their name, business address, business phone, fax, email information, and position in the company. This also included a brief biography about each person in a standardized format, completed by each person, and reviewed by the project managers. The roster included information about the citizenship of the person, languages that they speak, and

their avocations and interests. It is also important to elicit the religious beliefs of the participants so that the virtual team can respect the holidays that are celebrated. This must however be done with respect and consideration for privacy if people do not want to share this information.

The Internet can be a useful tool for managing company-wide CoPs, making it accessible to anyone on similar projects (Jewell and Walker, 2005). However, it is important that any web site used is refreshed regularly to update new information from the members, and to add or delete members from the project roster. When there are multiple companies involved, a single person should be made responsible for maintaining the roster. The roster system should include software to enable a person to search for others by the Figure 4 dimensions. Those deemed appropriate for the project roster, including title and company, can be "suggested" when members of the project perform the search. For example, one may search for rock climbers and receive a listing of people who have shown that as an area of interest. The software should also include a search mechanism, a blog where people can post a request or invitation or simply share thoughts, and keywords so that their interest may be added to the system (interest in cooking for example). Once CoPs form, then the member can request that their CoP name (Electrical Tiger Team for example) is annotated onto their individual records. This enables CoPs to form and build an identity, and it provides a way for the leadership of the project to recognize contributions to the project.

Information Sharing

The Nonaka and Takeuchi (1995) SECI model serves as a useful starting point in understanding how knowledge creation occurs as a flow of information that transforms tacit knowledge to explicit knowledge. There must be three ingredients for knowledge to be effectively transferred: information, context, and reflection. Information is of course too plentiful, so often the problem is sorting through all available data. This helps explain the rise in popularity of internet search engines, research search engines, and critical reviews of literature, plays, movies, and etc.

To use information effectively, people must be able to find what they need in a convenient and recoverable manner. For example, if you are a on a project in India and need to know what American Society of Mechanical Engineers (ASME) codes exist for a boiler, you would like to find a site where this information exists as a start. Once you find the site and see the organization of the code, you may be able to determine which sections or sections apply to your question. You could then zoom in on these and read them, save them, or print them out. Suppose that the ASME code tells you that the Authorized Inspector must affix a stamp to each boiler. In learning about what an Authorized Inspector is, you discover that you must now learn about how Authorized Inspectors are assigned in Japan—the information chain continues. In this example individuals need to be able to locate information sources, search through them effectively, and save or print this information.

Another form of information is personal experience. On all projects, the people assigned bring large amounts of varied experience with them. Often, companies will publicize their experience in tender documents with statements like "over 150 years of experience". Project personnel have experience that spans years, geographical locations, cultures, languages, technical expertise, education, and political experiences. Each person also has different people skills and attitudes, and different ways and speeds of learning. Thus, there is a wealth of information and knowledge that resides in the individuals on the project. The challenge is to identify it, and make it available and searchable globally. The roster described earlier provides one useful knowledge or

information search opportunity. On joining the roster, each person is asked to identify (by the use of an established menu of keywords) their experience and their education in topic areas pertinent to the project. Thus, when the roster is placed on the project website the information is readily available for others.

Having available and searchable information also aids in the formation of CoPs. A CoP cannot form if the people do not know where or how to find others of like interests. The roster is a way to fulfill this need and CoPs provide the context for the information that people have or discover. A CoP offers the benefit of a group with common interests that share a common language (unique blend of syntax and vocabulary associated with an area of interest) or context. Knowledge sharing can then occur much more readily because there is a common context for the group to assimilate information and transform it into knowledge. There are also synergies that exist for the group to then transform knowledge into innovation as graphically displayed in Figure 2.

The project website is another tool that has been developed recently by various software firms. Numerous software packages are designed to support CoPs. Ahlemann (1993) provides a useful study that reviews project management systems that rely on a project web hub for project information. The KM Review (2004), provides information on a number of CoP packages including ERoom, Sitescape Forum, EPS, Enable2, Business Workspaces, Sigma Connect^{tm}, Simplify, Lotus/IBM, and Microsoft. These software packages provide a basic operating environment that enables CoPs members to find one another and collaborate. However, experience and the literature (Peansupap and Walker, 2005b) indicate that a major consideration is the internet connection speed, especially in some developing countries (even in portions of the US). If a system is slow, then it does not matter how sophisticated the software is, people will not be inclined to use it.

Once the CoPs form, then there should be a convenient and recoverable communication system. Regardless of whether CoPs are co-located or virtual, an easy-to-use and rich system needs to be provided for CoPs to flourish. A CoP discussion space (discussion boards, blogs, wikis) needs to be created and maintained where discussions and communications are not readily available to those outside the CoP. The software should permit recording of the discussions for later reference. It is ideal if the software provides the capabilities for on-line audio communications, file sharing, whiteboard, and application sharing. These tools will provide the CoP with a rich environment in which to exchange views and ideas. They are critical if the CoP is a virtual one.

Time to Communicate

While it is generally believed that productivity has been increasing over the recent decades, metrics generally do not take account of the actual hours worked, only paid hours worked (ACIRRT - Australian Centre for Industrial Relations Research and Training, 1999). It is not unusual in the US for example, for salaried workers to work 50 or 60 hours per week. On international development projects, experience shows that 60-hour workweeks are standard. A key question for project leaders then is when CoPs have time to communicate. Generally, people have two choices, personal time or company time.

Wenger *et al* (2002) argue that leaders need to support organizational and individual learning by setting aside time when people can participate in CoPs, reflect upon their work, trade stories and ideas with co-workers, or catch up on professional theory and practice. Setting aside a dedicated hour twice a week for people to think will serve companies well. If such time is scheduled and budgeted for by project leaders, people have the chance to fall into the learning habit. If the individuals are required to participate only on their personal time, the probability of a CoP forming is small.

Time will also ultimately need to be provided for conferences, continuing education, and what some firms call "off-sites" or retreats. There is a significant body of literature on the benefits for these activities that speaks to the rejuvenations, synergistic, and team-building rewards from such opportunities (Edvinson, 1997; von Krough, 1998; von Krough *et al.*, 2000).

Project Motivation

Leaders are responsible for motivating their project team members. Good leadership builds trust, shows empathy, shares power, and communicates effectively (Goleman, 1998;2000). Effective leadership imbues a desire to emulate the leaders' characteristics throughout the organization (Bass, 1985). Motivation of the team by the project leader is critical for project management success, for creating a knowledge environment, and for the creation and nurturing of CoPs (Wenger, 1999).

Maslow (1943) argues that people have five types of needs in a hierarchy including psychological (food, water, clothing, shelter, etc), safety (from harm disease, etc), social needs (love, belonging, approval, etc.), esteem (self-respect, status, etc.), and self-actualization (growth, achievement, etc.). Herzberg *et al* (1959) concluded that motivating factors for employees were achievement, recognition, the work itself, responsibility, achievement, and growth. McFillen and Maloney (1988) surveyed USA construction workers and found that there were three key issues to be addressed in motivating or de-motivating people in this industry: clarity of expectations and task, interference with the work (lack of information, lack of planning, lack of leadership, etc), and intrinsic reward or punishment. Odusami (2002) found in his study that the most important skills for a project manager were decision making, communication, leadership and motivation, and problem solving. Ogunlana and Chang (1998) conducted a survey of projects in Thailand to test Maslow's hierarchy for construction in a developing economy. Their findings concluded that field workers function at the basic level due to their poor economic circumstances.

Clearly then, providing rewards and recognition is critical to success. Hagenbeek (2001) describes the strategy employed by HBG (the company name) was to enable people to participate, challenge people to participate, and communicate success. By challenging people to participate it is possible to reach those that are self-motivated. They can easily see the benefits to themselves, the company, and the project, and are likely to understand the benefits from sharing information and knowledge. As long as a knowledge environment exists and the tools and time are provided, these people will contribute and participate of their own free will. Successes can be celebrated in a variety of ways to reinforce and recognize the contributions for this group of people. Von Krough *et al* (2000) highlight examples that can include best information of the month, best knowledge transfer of the month (two or more kudos), best contributor of the month, etc. These celebrations can be no-cost options taking the form of a monthly web appreciation from leadership, added time off during the week, parking close to the office, etc. This type of motivation will capture those who are driven by recognition and self-fulfillment.

Von Krough *et al* (2000) also suggest examples of tangible rewards for sharing knowledge that can include such items as lunches paid for the contributor(s) for a week, paid training that has been requested, a week of time off, etc. At the more extreme end of the scale, bonus offerings and promotions can be set aside for year-end celebrations. A fund can be established for the top three best knowledge transfers on the project from an individual and from a CoP (care should be taken to keep the motivation as wide as

possible and not just focus on CoPs for many people will chose not to participate in one). One suggestion is to arrange a multi-company panel of people to evaluate the contestants. The options are only bounded by the imagination of an organization's leaders. Financial reward options could capture other large groups of people who have financial issues that they need to address. These rewards will serve to provide the motivation that they see as most important – as the earlier example of site laborers suggests. This will also serve to capture knowledge from those individuals who have a mixed set of needs that include rewards, recognition, and self-fulfillment.

Conclusions

The strategic management literature cited earlier, for example (Teece *et al.*, 1997), argues that knowledge is a valuable and strategic asset. The major challenge in any environment from business to academia is the creation of a knowledge environment that motivates the willing exchange of information and knowledge. Based upon experience and preliminary research outlined in this chapter, the creation of a knowledge environment appears to be not significantly different from that found in agile firms. Such firms welcome change, are innovative, thrive on risk, and maintain the respect and admiration of their employees and the broader community.

The key theme highlighted in this chapter is that CoPs deliver real value (through improved knowledge flows) to an organization, beyond immediate profit, from more effectively shared knowledge and expertise. However, CoPs cannot thrive without being nurtured by their host organizational bodies. A clear and simple visualization model of knowledge flowing like fluids in a pipe work system presented in this chapter provides a metaphor that helps us to consider the valves, potential blockage points and release mechanisms that must be considered in effective knowledge transfer and use. Many of the five needs explored relate to people-issues. It is of prime importance that leaders help to create and sustain an environment that supports CoPs. This includes sustaining a knowledge sharing environment; facilitating systems to help identify CoP members and support the formation of CoPs; supporting staff to transfer knowledge through the SECI processes; providing the necessary slack in the system so that people have the time to participate and organize CoPs; and finally, providing the necessary incentives and reward systems to motivate people to actively participate in CoPs. This chapter also provides experiential reflection (supported by data from three case studies) which can help project leaders design an effective knowledge environment that advances the chances of nurturing an effective CoP.

One important limitation of this study that must be acknowledged is that the analysis provided in this chapter is based upon reflective data sources. While the data is rich and based upon extensive experience gleaned from the principal researcher (and many other individuals involved in complex global engineering projects), it lacks any quantitative measures of benefits derived from the described CoPs. This is partially due to difficulties and current knowledge gaps in defining 'hard' productivity outcomes metrics for 'soft' inputs such as relationship qualities and knowledge transfer. Further research on developing productivity metrics for these 'soft' inputs would help to validate the value of nurturing CoPs on construction projects.

The major implications for practice highlighted by this chapter is that while organizations are developing CoPs for operational reasons, and have built them into their KM strategy, they still do not seem to have grasped the nettle in the construction sector to take their strategy one step further, to map as many CoPs that their staff take part in as is

practicable. If this were to be done, then organizations that do so may be in a better position to support external CoPs more effectively, and to help them influence the agenda of topics being discussed. This would have the advantage of allowing them to more readily access and use knowledge from supply chain members (competitors as well as collaborators), and to perhaps tap into new sources of knowledge, insights and strategically important learning resources. It would also encourage innovation through greater pull of knowledge from external knowledge sources, and gain feedback from knowledge push to these sources with corresponding feedback.

Maqsood, Walker and Finegan (2007) argue that organizations that better manage their people, processes and technology to interact more effective across the organization, as well with external knowledge sources, place themselves on a powerful innovation trajectory that can enhance their innovation and open up possibilities of greater competitive advantage. This chapter has indicated how this may be undertaken. It remains up to construction organizations to now take better advantage of the nurturing internal and external CoPs as an effective KM approach.

References

ACIRRT - Australian Centre for Industrial Relations Research and Training (1999). *Australia at Work - Just Managing?*Sydney Prentice Hall.

Ahlemann, F. (1993). *Comparative Market Analysis of Project Management Systems*. IPMA Conference, Moscow**:** CD-ROM, 8pp.

Bass, B. M. (1985). *Leadership and Performance Beyond Expectations,* , Free Press, New York.

Bontis, N., Crossan, M. M. and Hulland, J. (2002). "Managing An Organizational Learning System By Aligning Stocks and Flows." *Journal of Management Studies*. **39** (4): 437.

Brown, J. S. and Duguid, P. (1991). "Organisational Learning and Communities of Practice: Towards a Unified View of Working, Learning, and Innovation." *Organisational Science*. **2** (1): 40-57.

Coghlan, D. (2001). "Insider Action Research Projects: Implications for Practicing Managers." *Management Learning*. **32** (1): 49-60.

Coghlan, D. and Brannick, T. (2005). *Doing Action Research in Your Own Organization*.Second.London Sage Footprint.

Crossan, M. M., Lane, H. W. and White, R. E. (1999). "An Organizational Learning Framework: From Intuition to Institution." *Academy of Management Review*. **24** (3): 522-537.

Edvinson, L. (1997). "Developing Intellectual Capital at Skandia." *Long Range Planning, Elsevier Science Limited*. **30** (3): 366-373.

Eisenhardt, K. M. and Martin, J. A. (2000). "Dynamic Capabilities: What are They?" *Strategic Management Journal*. **21** (10/11): 1105-1121.

Fernie, S., Green, S. D., Weller, S. J. and Newcombe, R. (2003). "Knowledge Sharing: Context, Confusion and Controversy." *International Journal of Project Management*. **21** (3): 177-187.

Gherardi, S. and Nicolini, D. (2002). "Learning in a Constellation Of Interconnected Practices: Canon or Dissonance." *Journal of Management Studies*. **39** (4): 419-437.

Goleman, D. (1998). "What Makes a Leader?" *Harvard Business Review*. **76** (6): 92-102.

Goleman, D. (2000). "Leadership that Gets Results." *Harvard Business Review*. **78** (2): 78-90.

Grabher, G. (2004). "Cool Projects, Boring Institutions: Temporary Collaboration in Social Context." *Regional Studies*. **36** (3): 205.

Grant, R. M. (1991). “The Resource-Based Theory of Competitive Advantage: Implications for strategy Formulation.” *California Management Review*. **33** (3): 114-135.
Grant, R. M. (1996). “Toward a Knowledge-Based Theory of the Firm.” *Strategic Management Journal*. **17** (Winter Issue): 109-122.
Grisham, T. (2006). Cross-Cultural Leadership. Melbourne Australia, RMIT**.**
Grisham, T. and Srinivasan, P. (2007a). *Designing Communications on International Projects*. CIB World Building Congress, Cape Town South Africa,
Grisham, T. and Srinivasan, P. (2007b). *Designing Risk on International Projects*. CIB World Building Congress, Cape Town South Africa,
Grisham, T. and Walker, D. H. T. (2006). “Nurturing a knowledge environment for international construction organizations through communities of practice ” *Construction Innovation: Information, Process, Management* **6** (4): 217-231.
Hagenbeek, J. (2001). “Creating and Marketing Connections at HBG.” *Knowledge Management Review*. **4** (5): 28-32.
Herzberg, F., Mausner, B., Snyderman, B. (1959). *The Motivation to Work*.New York Wiley.
Hildreth, P., Kimble, C. and Wright, P. (2000). “Communities of Practice in the Distributed International Environment.” *Journal of Knowledge Management*. **4** (1): 27-38.
Jewell, M. and Walker, D. H. T. (2005). Community of Practice Perspective Software Management Tools: A UK Construction Company Case Study. *Knowledge Management in the Construction Industry: A Socio-Technical Perspective*. Kazi A. S. Hershey, PA. Idea Group Publishing**:** 111-127.
Kanter, R. M. (1989). *When Giants Learn to Dance: Mastering the Challanges of Strategy, Management and Careers in the 1990's*.London Simon & Schuster.
KM Review (2004). “What is the best software supplier for communities of practice?” *KM Review*. **7** (2): 4.
Lave, J. and Wenger, E. C. (1991). *Situated Learning - Legitimate Peripheral Participation*.Cambridge Cambridge University Press.
Lawrence, T. B., Mauws, M. K., Dyck, B. and Kleysen, R. F. (2005). “The politics of organizational learning: Integrating power into the 4I framework.” *Academy of Management Review*. **30** (1): 180-191.
Lewin, K. (1947). “Frontiers in Group Dynamics.” *Human Relations*. **1** (1): 5-41.
López, S. V. (2005). “Competitive Advantage and Strategy Formulation: The Key Role of Dynamic Capabilities.” *Management Decision*. **43** (5): 661-669.
Maqsood, T., Walker, D. H. T. and Finegan, A. D. (2007). “Facilitating Knowledge Pull to Deliver Innovation through Knowledge Management: A Case Study.” *Engineering Construction and Architectural Management*. **14** (1): 94-109.
Maslow, A. H. (1943). “A Theory of Human Motivation.” *Psychology Review*. **50**: 370-396.
McFillen, J. M. and Maloney, W. F. (1988). “New answers and new questions in construction worker motivation.” *Construction Management and Economics*. **6** (1): 35-48.
Nishida, K. (1958). *Intelligibility and the Philosophy of Nothingness*.Honolulu East-West Center Press.
Nonaka, I. and Konno, N. (1998). “The Concept of 'Ba': Building a Foundation for Knowledge Creation.” *California Management Review*. **40** (3): 40.
Nonaka, I. and Takeuchi, H. (1995). *The Knowledge-Creating Company*.Oxford Oxford University Press.
Odusami, K. T. (2002). “Perceptions of Construction Professionals Concerning Important Skills of Effective Project Leaders.” *Journal of Management in Engineering*. **18** (2): 61-68.

Ogunlana, S. O., and Chang, Wei Pien (1998). "Worker Motivation on selected construction sites in Bangkok Thailand." *Engineering Construction and Architectural Management*. **5** (1): 68-81.
Peansupap, V. (2004). An Exploratory Approach to the Diffusion of ICT Innovation a Project Environment. PhD, *School of Property, Construction and Project Management*. Melbourne, RMIT University.
Peansupap, V. and Walker, D. H. T. (2005a). Diffusion of Information and Communication Technology: A Community of Practice Perspective. *Knowledge Management in the Construction Industry: A Socio-Technical Perspective*. Kazi A. S. Hershey, PA. Idea Group Publishing: 89-110.
Peansupap, V. and Walker, D. H. T. (2005b). "Factors Affecting ICT Diffusion: A Case Study of Three Large Australian Construction Contractors." *Engineering Construction and Architectural Management*. **12** (1): 21-37.
Peansupap, V. and Walker, D. H. T. (2006). "Information Communication Technology (ICT) Implementation Constraints: A Construction Industry Perspective." *Engineering Construction and Architectural Management*. **13** (4): 364-379.
Schön, D. A. (1983). *The Reflective Practitioner - How Professionals Think in Action*.Aldershot, UK BasiAshgate ARENA.
Sense, A. J. (2003). "A Model of the Politics of Project Leader Learning." *International Journal of Project Management*. **21** (2): 107-115.
Sense, A. J. (2005). Cultivating Situational Learning Within Project Management Practice. PhD, *Macquarie Graduate Shool of Management*. Sydney, Macquarie University.
Skyrme, D. J. (1999). *Knowledge Networking - Creating the Collaborative Enterprise*.Oxford Buterworth-Heinermann.
Snowden, D. J. (2002). "Complex acts of knowing: paradox and descriptive self-awareness." *Journal of Knowledge Management*. **6** (2): 100-111.
Spender, J.-C. (1996). "Making Knowledge the Basis of a Dynamic Theory of the Firm." *Strategic Management Journal*. **17** (Winter Issue): 45-62.
Storck, J. and Hill, P. A. (2000). "Knowledge Diffusion Through "Strategic Communities"." *Sloan Management Review*. **41** (2): 63-74.
Teece, D., Pisano, G. and Shuen, A. (1997). "Dynamic Capabilities and Strategic Management." *Strategic Management Journal*. **18** (7): 509-533.
von Krough, G. (1998). "Care in Knowledge Creation." *California Management Review*. **40** (3): 40-54.
von Krough, G., Ichijo, K. and Takeuchi, H. (2000). *Enabling Knowledge Creation*.Oxford Oxford University Press.
Walker, D. H. T. (2005). *Having a Knowledge Competitive Advantage (K-Adv) A Social Capital Perspective*. Information and Knowledge Management in a Global Economy CIB W102, Lisbon, 19-20 May, Franciso L Ribeiro, Peter D E Love, Colin H. Davidson, Charles O. Egbu and B. Dimitrijevic, DECivil, **1:** 13-31.
Weick, K. E. (1995). *Sensemaking in Organizations*.Thousand Oaks, CA Sage.
Weick, K. E. (2001). *Making Sense of the Organization*.Oxford Blackwell Publishers.
Wenger, E. C. (1999). "Learning as Social Participation." *Knowledge Management Review*. **1** (6): 2-6.
Wenger, E. C., McDermott, R. and Snyder, W. M. (2002). *Cultivating Communities of Practice*.Boston Harvard Business School Press.
Wenger, E. C. and Snyder, W. M. (2000). "Communities of Practice: The Organizational Frontier." *Harvard Business Review*. **78** (1): 139-145.
Winter, M., Smith, C., Morris, P. and Cicmil, S. (2006). "Directions for future research in project management: The main findings of a UK government-funded research network." *International Journal of Project Management*. **24**: 638-649.