Transferring Tacit Knowledge in Extended Enterprises

Susu Nousala
Econ-KM
PO Box 642
South Melbourne, Vic, Australia
susunousala@econ-km.com

William P. Hall
Australian Centre for Science, Innovation and Society (ACSIS)
University of Melbourne
Vic., Australia
whall@unimelb.edu.au

Sabu John
Aerospace, Mechanical and Manufacturing Engineering
RMIT University
Bundoora East, Vic, Australia
sabu.john@rmit.edu.au

Abstract - *Organizations need to build and use knowledge to remain viable in the face of competition and change. Due to the limits of organization and the bounded rationality of individuals working within the organizations it is impossible to make all of the required knowledge accessible in explicit and readily retrievable formats. Much of the knowledge an organization needs is held tacitly by members of the organization. This "personal knowledge" is normally inaccessible to other members because they have no way to know that it exists. Communities of practice help to mobilize personal knowledge. In this paper we present and discuss the emergence of communities of practice, some tools, concepts and an ontology we have prototyped to facilitate the development of these communities. Such communities provide avenues for sharing and transferring normally hidden knowledge.*

Keywords: Knowledge sharing, communities of practice, tacit knowledge, extended enterprise, emergence.

1 Organizations are based on knowledge

Pragmatic experience in the discipline of organizational knowledge management highlights the importance of communities of practice ("CoPs") as mechanisms for building organizational knowledge. We are concerned to understand how CoPs fit into the overall organizational needs for knowledge, how they form and how they can be sustained to meet dynamic organizational needs.

The concepts presented here are developed in a biological theory of organization that treats enterprises and other self-sustaining economic organizations as complex adaptive (i.e., "living") entities that exist independently of any particular individual who may belong to the organization from time to time [13],[14],[15]. This work also reflects experience from real-world prototypes [27], [30]. Following the biological paradigm, organizations are complex and dynamic entities [44]. To survive and sustain themselves in competitive or changing environments, organizations must continually create and maintain knowledge to solve solutions to problems they encounter in their existence [6],[7]. Based on Karl Popper's epistemology [14],[35],[37], such solutions are the organization's knowledge. Enterprises change and adapt via individual learning of their members, and the linkages and relationships these members form on multiple levels of complexity within the organization [48].

Organizational survival or sustainability requires compatible and renewable interconnectedness, where learning emerges from tensions between problems, ideas and actual practice. To be useful, learning from both failed and successful problem solving must be retained as knowledge in corporate memory [31],[32]. Due to the bounded rationality of individuals [40],[41] and limits of organization [1], much survival knowledge is not made explicit, and thus remains available only to the individuals who directly solved the problems. In this paper we present the paradigmatic framework and some background thoughts relating to our ongoing studies showing that the essence of organizational sustainability resides within a well-created contextual environment where knowledge growth, evolution and exchange are facilitated by the emergence of various kinds of working groups and communities of practice (CoPs) within the organization.

2 Biological theory of organization

Our theoretical paradigm is grounded in two frameworks: (a) Maturana and Varela's concept of autopoiesis [19],[46] and (b) Karl Popper's epistemology as expressed in Objective Knowledge [35] and later works [36],[37].

Autopoiesis is a term [18],[19],[46] expressing the minimum set of properties a complex system must have to be considered living: (a) distinguishably differentiated from the surrounding world, (b) complex, (c) mechanistically dynamic, (d) self referentially bounded, (e) system components self-produced, and (f) self-produced components necessary and sufficient to produce the system (autonomy). Maturana and Varela argued that taken together these six criteria were necessary and sufficient to define a discriminable system to be living. Self-reference implies the involvement of cyclical learning processes to maintain self-sustainability in changing environments.

Popper's worldview [35],[36] includes a metaphysical ontology of three domains or "worlds": World 1 (W1) is uninterpreted external reality. World 2 (W2) is the domain of living cognition and "dispositional" knowledge embodied in the instantaneous structure of living things (e.g., possibilities inherent in physical structures, neural connections, living memory, etc.). W2 encompasses Polanyi's personal and tacit knowledge [14],[33],[34]. World 3 (W3) includes explicit or "objective" knowledge such as the logical contents of books and computer memories or other products of human cognition ([35] p. 115). Critical scientific realists [23] accept the existence and importance of all three worlds, and argue that claims constructed in W2 to know the truth of the "real" World 1 can be expressed as theories in W3 that can be evaluated and improved in W2 through cycles of action; i.e., testing claims, observing results of the action, and criticizing the observations against the claims.

Autopoiesis was applied to social/economic organizations by von Krogh and Roos [48] and Magalhaes [16],[17]. The biological theory of organization [13],[14], [15] combines Popper's epistemology with autopoiesis.

For organizations to maintain themselves against entropy, change and competition, they must assemble, deploy, preserve and replicate knowledge responding to problems. Knowledge in the organizational context is any kind of information that has survival value [30]. The growth of knowledge and learning at any level of organization is cyclical, summarized by Popper's "tetradic schema" [35]:

$$\mathbf{P_n \rightarrow TT/TS \rightarrow EE \rightarrow P_{n+1}}$$

$\mathbf{P_n}$ is a problem. **TT/TS** are guesses, tentative theories or tentative solutions to that problem. **EE** is an error elimination process that removes those theories or attempted solutions that fail to solve the problem. $\mathbf{P_{n+1}}$ is the somewhat changed, new problem state faced by the entity that has solved $\mathbf{P_n}$. Similar adaptive learning cycles are "double loop learning" [3], "SECI" [25], and Boyd's "OODA loop" [4],[11],[12],[13],[45]. Organizational sustainability requires positive and negative constraints within the dynamic structure of the organization to support the emergence and sustenance of learning cycles. Organizational learning provides a way to build positive and negative constraints into the structure of the complex system. Organizational learning cycles begin with and involve coordinating the learning cycles of the organization's individual members, who then share, combine and extend personal knowledge to build organizational knowledge and strengthen the organization.

3 Personal and tacit knowledge in the organization

We focus here on roles individuals and systems of individuals play in higher levels or organizational structure. Personal knowledge (in W2) is embodied in individual dispositions, propensities, cognition and living memory. 'Tacit knowledge' introduced by Polanyi [33],[34] is commonly used in knowledge management, yet there are difficulties over its meaning [44]. Nickols [22] defines three forms of knowledge: tacit - consisting of skills and natural talent that cannot be articulated verbally, implicit - that which could be articulated but has not been, and explicit - that which has been articulated and recorded in some persistent form. Tacit and implicit knowledge are personal or "subjective" and remain 'living' in Popper's [35] W2. In our simple vernacular usage here, tacit includes implicit unless stated otherwise. Explicit knowledge is that which has been objectively codified and can exist persistently in W3.

A person's tacit knowledge (TK) is difficult to codify explicitly as it often remains fluid until ready to be articulated for transfer to another individual or group. This exchange involves moving the individual's personal experience or idea from the tacit to a more explicit form of expression articulated to meet an immediate requirement. Such personal expression also depends on engaging the immediate environment. Environment strongly influences knowledge exchange as it provides recipient(s) with a context for explicit expressions. The tacit knowledge exchange (TKE), begins with an individual articulating what was tacit, who then communicates with others, who can then make the knowledge personal, further build on, and apply it to meet organizational needs. For an isolated individual seeking to comprehend and make personal someone else's explicit expression (from one person's TK to another person's TK, i.e., TKE), the transfer may fail because there is no shared context providing personal meaning for the first person's explicit expression. TKE is required for effective organizational communication and learning, but is not always efficient or successful, or simply may be impossible, as the environment offers no support to create a cycle of exchange.

4 Tacit knowledge networks (TKN) and tacit protocols

Building organizational knowledge in learning cycles involves interactions among the human members of the organization. These cycles translate into evolutionary changes in organizational behavior that also involve changes to individuals' behavior in the organization — in what can be described as organic, evolving phenomena [8],[9],[10]. In organizational learning cycles individuals build personal tacit knowledge through TKE within organizational contexts that are often also tacit [49],[26]. Individuals may then codify what was tacit and linguistically express this in explicit form. The explicit expression can then be shared and distributed to be embodied again by other individuals as tacit knowledge. However, what has been codified is not tacit, and the absence of a shared contextual background may lead to

misunderstanding by those who only have access to the explicit record. As described by Choo [5], direct tacit-to-tacit knowledge may also be "regularly" transferred by "imitation". Choo gives examples of environments supporting such imitations: apprenticeships, internships, or on-the-job training schemes. In either case, connections involving the expression and sharing tacit knowledge between individuals form what we call '*tacit knowledge networks*' (TKN). Continuous learning cycles requiring TKE create various kinds of TKNs that may differ in their capabilities to build and share the kind of knowledge the organization needs.

'*Tacit protocols*' are aspects of structural organization in the form of dynamic physical and social processes (i.e., "routines" in Nelson & Winter's sense[20]) that contribute to and facilitate TKE. Tacit protocols both (a) exist as part of the organization's tacit knowledge, and (b) are concerned with the exchange among individual organization members of personal tacit knowledge of organizational significance. Communities of interest (CoI) [27],[29] and communities of practice (CoP) [49] are examples of tacit protocols facilitating the creation and sharing of organizational knowledge.

5 Community emergence

5.1 Modeling and testing

Case studies by Nousala [27] and Nousala et al.[30] identified important processes in forming tacit knowledge networks. Some networks had structural similarities that seemed to contribute to overall organizational sustainability.

Formation of CoIs and CoPs enables TKE and sustainable learning, and this occurs in several ways. These are communities of people, who interact for particular reasons [26], [49]. Communities can vary in size, but in our case studies, there always seem to be binding influences for such groups. Typically, core individuals share an understanding or passion that energizes a group and bonds participants. This sharing provides intellectual and practical benefits and social support [29],[30].

Models need to reflect the dynamics or tensions individuals face within an organization: "It suggests a dilemma that all managers grapple with: the organizational tension between process, the way matters are formally organized, and practice, the way things actually get done. Managers find this tension difficult to handle." ([38] p. 74). Although managers are primarily responsible for resolving them, these tensions are recurring and thus part of the constraints governing the evolving phenomena of practice. The primary tension is process vs practice ([38] - Table 1).

Any models intended to represent tacit/explicit exchanges would need to consider:

1. What knowledge sharing challenges are faced in the organization?
2. What are key defining elements between individuals, group, organization and environment?

Table 1. Process vs Practice [38]

Process	*Practice*
The way tasks are organized	The way tasks are done
Routine	Spontaneous
Orchestrated	Improvised
Assumes a predictable environment	Unpredictable environment
Relies on explicit knowledge	Driven by tacit knowledge
Linear	Web-like

5.2 Conceptual background for studying CoP emergence

The concept of individuals exchanging knowledge through their connections resembles the improvised or spontaneously emergent web-like practice described in the last line of Table 1. If actual practice is too chaotic, new ideas may never become organizational knowledge. On the other hand, if work processes are too restrictive, there is no space for voicing, discussing and exchanging new ideas [38],[39]. TKE is crucial when problems arise in a rapidly changing environment. To adapt, the organization needs to exchange ideas and rapidly build knowledge in fairly fluid or "live" situations, which CoPs can offer [26].

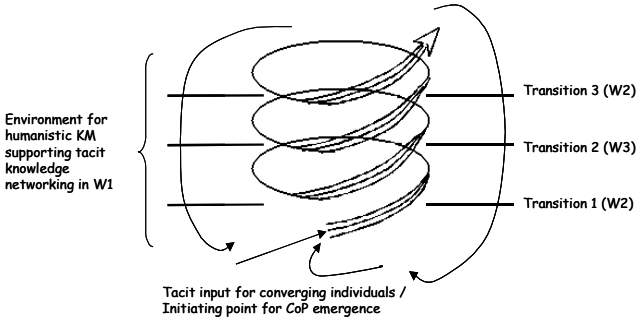

Figure 1. The tacit → explicit → tacit spiral upwards to the next level (from Nousala 2003; Nousala et al. 2005b)

The concept illustrated in Figure 1 is similar to the bottom-up approach expressed in the CoP literature, and especially in Nonaka and Takeuchi's SECI loop process for tacit knowledge exchange ([25] p. 62). In SECI, the transitions represent shifts between individuals' development of tacit

knowledge (W2), their articulation in an objective form able to be shared and intersubjectively criticized (W3), and the tacit embodiment of the criticized knowledge in other (and more) individuals where it can be further developed in action:

Processes within the CoP structure cyclically transform knowledge between tacit forms in W2 and explicit forms in W3. This CoP, as an entity, may build larger knowledge networks either within the boundaries of the parent organization or crossing the boundaries of several organizations having similar knowledge needs. As Popper notes [35], the learning cycles are not exactly repeatable, as the incremental additions of tested knowledge change the nature of the problem state from one cycle to the next. The following explains the transition levels of the model in Figure 1. Time and practice is the vertical dimension, evolving to the next level:

- Transition 1 = TK re problem states, forming initiating points;
- Transition 2 = TKE, involving the articulation of knowledge evolving to the next level;
- Transition 3 = new TK solution with adjustments to new constraints, an on going process.

Between each transition is "time and practice". The community uses time to put its knowledge into practice (i.e., to test it). Each of the transition levels 1, 2 and 3 represents an exchange to or from tacit knowledge. Management of the tension between process and practice happens on many levels of organization. Without good understanding, the tension will be difficult to manage. It will also be hard to identify developing knowledge communities in the workplace, or to even know where to begin the identification process [24],[26]. This beginning or initiation point is what many workers may grapple with when looking at the knowledge creation and exchange process as a whole.

Establishing a situational context seems to be a distinct process within the tacit realm that differs from Nonaka and Takeuchi's tacit to explicit exchange [25]. The situational context and content state appears to exist prior to that of the tacit explicit to exchange and that context is almost immediately lost once effective TKE begins. However, it is no less important for its short existence. It may help explain why it is difficult to see what makes an effective tacit exchange better, or to develop an ontology of TKE between individuals, groups or organizations [26]. The basic elements of TKE, such as communication approaches and the time required for tacit exchanges, need to be understood. The elements that Nonaka and Takeuchi (1995) touched on [25] and that Snowden [42] and Nousala [26] further summarized are as follows:

1. Aspects of the physical and social environment supporting tacit exchange (people's W2) vs purely physical environment for transferring explicit documents (W3).
2. Tacit context and content and its relationship with an ontology (of what?).
3. The relationships between circumstances, tacit context and content, and transition or exchange within any of the relevant spiral TKE cycle models.
4. The positioning of tacit context and content in relation to tacit and explicit models.

The environment for TKE seems to be the major factor.

If particular kinds of elements are important in the emergence of tacit protocols, what models can be developed to express interaction so that it can become visible? Bertels and Savage ([2] p. 10) ask, "What models can support expression of aspirations so that they become visible and valued 'idea assets'?" They discuss the need for people to recognize the value of each other's work and initiate real dialogue to make the work explicit. Nonaka and Takeuchi [25] discuss tacit and explicit knowledge and how individuals make this available to the organization. However, Bertels and Savage suspect that knowledge may exist in several layers of organizational hierarchy, and suggest that these layers of knowledge interact to create knowledge processes. They also suggest that there may be "A relationship between the level or depth of knowledge and its impact on the organization over time … [T]here is something that makes a difference, but we lack the language to address that difference"(p. 20), and cite the need for interrelated topics to be investigated through action research. Venzin et al. [47] note that, because the process of knowledge formation is lengthy and only partially repeatable in detail, new tools are needed to see and understand emergent patterns.

Combining Polyani's concepts of personal knowledge, Popper's W2 and W3 and autopoiesis provided a framework for Hall et al. [15] and Nousala et al. [30] to investigate the importance of W2 knowledge in evolving interactive relationships to address organizational problems. This evolving interactive relationship is important to developing and implementing tacit knowledge networks and "mirroring" the developed knowledge in objective (W3) structures.

5.3 Emerging CoPs are important tacit protocols for building organizational knowledge

Research to understand factors initiating emergence of organized communities within large organizations began with an ontology of community types [30]:

- Community of Interest (CoI) - loose aggregations or networks of people forming general communities or

working groups around some kind of common interest.

- Expert Community of Interest (ECoI) – CoI comprised of acknowledged experts in a specific discipline.
- Community of Practice (CoP) – a more formalized and self-sustaining group of people who share a concern or a passion for something they do and who work to learn how to do it better as they interact regularly.

We then established the concept of "human attractors" [30] p. 22), who are well known or charismatic people within the organization whose activities network people within (and possibly outside) the organization who have expert knowledge in particular fields to form ECoI. If motivated to do so for organizational purposes, human attractors can also initiate links to CoIs [26],[28], which were more general communities or working groups and which may be further linked to form more mature and sustainable CoPs. Having identified human attractors we were then able to focus on how they might work to organize the emergence of CoPs as tacit protocols. From this we should be able to understand how CoPs influenced other tacit aspects of corporate structure, allowing knowledge to cross boundaries [20],[21] and enable adaptive adjustments to culture, strategies, structure and environments on an ever-evolving basis [26],[28].

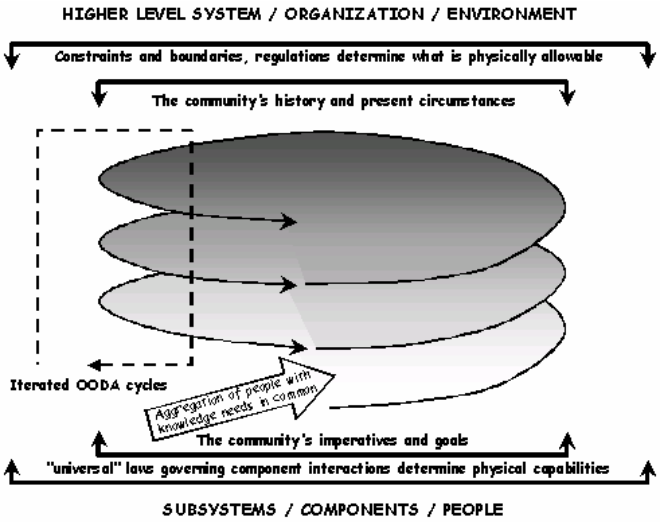

Figure 2. Community of practice emergence as constrained by higher and lower level systems.

Figure 2, extending the concepts of Figure 1, illustrates our understanding of conditions supporting the emergence of a functional CoP addressing a particular organizational problem.

6 An ontology for tracking personal knowledge

A series of semi-structured interviews were conducted, supported by the mind mapping tool (Mind Manager). An analysis of the individual transcripts focused on the interviewees' careers. These were broken down into categories of knowledge in their career contexts. The mind mapping tool assisted the individual through the process by retaining the focus of their experiences on who knew whom, what, where, when, why and how. The analysis of the results was based on a specific emergent ontology to capture the various experiences in context. The ontological structure also provided the basis to construct an organizational roadmap linking categories of knowledge to the individuals who have it. Nousala et al. [30] illustrate this ontology graphically.

7 Conclusions

Case studies revealed that certain key individuals were important "human attractors" who were important parts of, or initiated, communities or groups. As such, human attractors were instrumental in developing expert communities of interest. ECoIs were communities that existed due to the specific expertise required by the organizations. Human attractors as initiators were the precursors to ECoIs and were also precursors to the more general communities of interest (CoI). Both of these communities of interest were precursors to the CoPs which became self-sustaining organizations in their own rights as subsystems within the larger organization – at least as long as the problems they addressed remained important to the overall organization.

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(Note: all URLs valid as at 18 April 2007)

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