INFORMATION, KNOWLEDGE AND THE CONTEXT OF INTERACTION

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Abstract

Representing knowledge as information content alone is insufficient in providing us with an understanding of the world around us. A combination of context as well as reasoning of the information content is fundamental to representing knowledge, within information –based systems. The field of knowledge representation and knowledge management has thus far been concerned with providing structures and theories that can lead to some form of qualified intelligent reasoning, and contextualised information. By drawing upon previous research and applying and extending concepts of Semiotics and Symbiosis from the interaction design school of thought, this paper presents a conceptual framework for establishing the interplay between knowledge and users of knowledge via information systems constructs. Subsequently, by drawing upon notions of interfaces to knowledge, a conceptual framework which describes the relationship between the semiotic, symbiotic and interface to knowledge presented, along with a discussion of contemporary issues common to the field of knowledge management is developed.

Keywords: Knowledge Management, Information Systems, Conceptual Framework.

1 INTRODUCTION

Ever since the wide-scale availability of commercially available email and World Wide Web access, the knowledge needs of the connected individual has meant that information has evolved into ever more sophisticated requirements. Viewing, distributing, purchasing and manipulating information for our own needs has now become a priority in the way people manage the relationship between information and knowledge (Sharif, 2002a). The true essence of the internet, information and knowledge revolution is that it is based upon people. Where many individuals, organizations and nations have routinely flounder in comprehending the nature of the 'e' revolution, is in this realization of the human interaction factor. Accessibility, functionality, and aesthetic characteristics are beginning to blur the form of technology-based products and services, warping technology into a series of lifestyle choices (for example, the convergence of mobile phone, PDA, digital camera is a case in point). In many instances, the evolution of technology as information enabler, to technology as knowledge instrument, is beginning to lead and radically change the way in which businesses operate and market themselves. This is especially true for those companies and sectors where intellectual capital is the core product, such as in the professional services industry (Sharif, 2002b).

In simple terms, this is no more a new economy of value chains, branding, market share and / or technology than it is of the ubiquitous consumer. Given that these monumental changes have occurred, where does information and more importantly knowledge exist in this dynamic continuum? The challenge perceived by researchers such as Sveiby, is to channel and harness the information requirements of people and manage technology in such a way as to transfer codified knowledge more effectively (Sveiby, 2001). But simply expanding the accessibility and breadth of information will not provide us with any further understanding of the human perspective. What is required, is a deeper understanding of the nature of the interaction between information, knowledge and the end-user and the bounds within which we operate in order to make best use of these structures (such as for example, approaches to integrate knowledge and information within the components of an enterprise, Badii and

Sharif, 2002). As such, this paper seeks to provide an analysis of the key themes of knowledge structure and interaction and presents a conceptual framework for establishing both the semiotic (language of signs and symbolism) as well as symbiotic (relational / causal) implications of representing knowledge in information systems in this light. In doing so, this provides a basis for understanding and extending interaction, codification and transfer of knowledge between and to contingent forms of information and knowledge which are typically experienced within organisational and other forms of information systems. As a result the given TAPE framework attempts to conceptually bring together those people, process and technology components of knowledge and information. The paper is structured as follows: following the introduction a brief background and overview to both the symbiotic and semiotic schools of thought, and their associated impact upon information systems is given via definitions of IT/IS and knowledge management approaches. A subsequent model for representing semiotic and symbiotic concepts is then provided which forms the basis for the resulting conceptual TAPE framework. This framework seeks to extend notions of knowledge management in the light of both the former concepts, and in terms of how organisational information systems can leverage the given concepts further. The author further discusses and presents definitions of knowledge representation, codification and management, and how these issues can best be researched going forward. Finally, the paper concludes by providing recommendations as to how and where the discussed concepts of semiotic and symbiotic knowledge can be integrated into information systems.

2 UNDERSTANDING KNOWLEDGE AND ITS INTERFACE

The author now presents several pertinent concepts relating how information and knowledge are inter-related as the basis for developing a conceptual framework which attempts to bring together a relationship between causal and relational forms of information and knowledge.

2.1 Defining data, information and knowledge

As noted in Sharif and Irani (2004), Knowledge is based upon the refinement of the concept of data and information (the interpretation of data) and is the natural outcome of understanding and using information within a particular context. Polanyi famously stated that knowledge which is impossible to define fully (Polanyi, 1966) or even more simply, as the accumulation and cultivation of information and data over time (Leonard-Barton, 1995). Knowledge can further be segmented into direct or *explicit* knowledge or indirect, implicit or *tacit* knowledge (Nonaka and Takeuchi, 1995). Again, for the purposes of this paper, the focus is given to viewing the interaction and relationship of knowledge within an organisational or systems context in terms of Sorensen and Kakihara's first three discourses: object, interpretation and process (Sorensen and Kakihara, 2002). In other words, those forms of knowledge which begin from purely data / information (structural), through to an information context (interpretive), and finally through to usable knowledge (evaluative). Given these points, it can be seen that these are just a few out of the many definitions of knowledge which exist, each with their own specific connotations and theoretical grounding. As Syed has shown, the implementation of knowledge within computing and information systems is indeed vast, as shown in Figure 1 (derived by the author from Syed, 1998). In Syed's diagram, specific tools and technologies are situated within a range of low to high complexity, from textbooks all the way up to systems which exhibit emergent behaviour. Sorensen and Kakihara (2002), also define knowledge within an IS setting, in terms of four "discourses": knowledge as an object (in order to support information distribution); as an interpretation (in order to filter information); as a process (to coordinate and collaborate across information structures); and lastly, as a relationship (in order to provide interaction between individuals and systems).

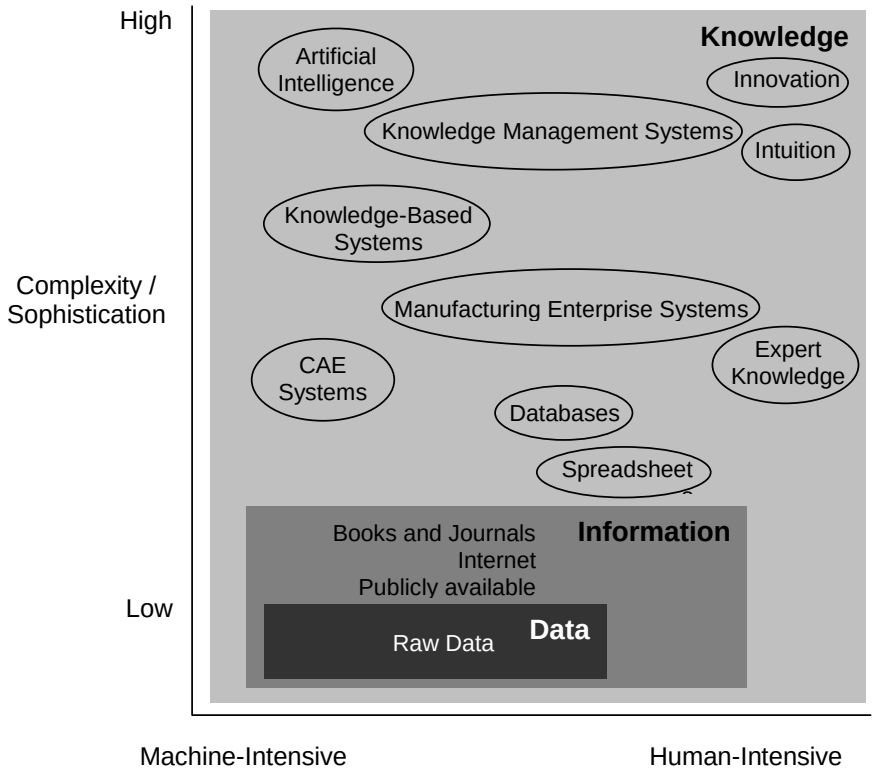

Figure 1. The knowledge landscape within IS (modified from Syed, 1998)

2.2 Defining IS and IT

It is clear that many information and other forms of system contain, consume, generate and supply data, information and knowledge. However the boundaries between Information Technology (IT), which encompasses hardware, software and peripheral devices, and Information Systems (IS), which encompass the socio-technological aspects of IT usage, have increasingly blurred. Where the distinction between IT and IS occurs, is in the way in which IS typically refers to environments which support the flow of information between human stakeholders, in order for that information to be processed. Once processed, this information is then utilisable in such a way as to be useful for other information flow tasks (such as decision making, problem solving and the like). Thus, and as Gupta (1996) states, an IS is a system which predominantly creates, processes, stores and retrieves information. With the continual increase in computer performance, and the manner in which computers are utilised to assist in information-intensive tasks, the importance of understanding the interface and relationship between information and knowledge, is then increasingly important.

Perversely, this has also subsequently led to an increase in the complexity of the knowledge contained therein, and the related consumption of that knowledge. The complexity of managing and representing knowledge in its most effective form, thus becomes paramount.

2.3 The Semiotic / Symbiotic perpective

There is a clear need to not only understand the process of creating, storing and disseminating information within an information system (i.e. the codification), but also to understand the manner by which such information is both presented and used in relation to individuals (i.e. the sublimation of information into useful data, or knowledge). Sorensen and Kakihara (2002) note the importance of understanding the ways in which technologies construct individuals and organisations and the ways in which these entities then construct the same. This further elucidates the contingent differences between IT and IS, and seeks to highlight the fact that purely encoding data in itself does not provide a context for using information and harnessing knowledge effectively.

This latter approach attempts to place the emphasis on understanding the interface between technology, usability and information flows, and identify where such interfaces exist (Cooper, 1995). In terms of the latter interaction-based design approach, the role of the information consumer becomes paramount, and the context of the artefact that has been designed, metamorphosis's into an extension of that interface (Wilson, 1997). Thenceforth, no clear distinction can be made between what constitutes the artefact and what constitutes the person interacting with it. This step change in technology is implicit in many knowledge-based tasks and is at the heart of the development of many information-dependent communities (Scherer, 2000).

Merali (2002) suggests that information (and hence knowledge) also exists through self-organising behaviour, in an autopoeitic, continuously self-reproducing, manner. Further, such an autopoeitic effect consists of a series of interactions across the boundary of an individual or organisation via a collection of beliefs and relationships (schema); an identity (self-concept); a set of rules and premises that bound the knowledge (relationship script); and the manner by which such knowledge relationships are enabled (relationship enactment). The stance taken by Merali, then, suggests that knowledge can be represented best when all the components of that knowledge, somehow reinforce their interrelationships by not only their existence but also by the level of their interaction as well. Therefore detailing and enforcing both semiotic and symbiotic concept.

Thus, the successful interpretation of the interface between man and machine is dependent upon the ability to link human processes with artificial constructs which mimic how we think and structure artefacts. For example, Kock and McQueen (1998) have defined information systems and the methods of communication with them, as a continuous cycle of interpretation and change. With each new understanding of the context of information, modified knowledge rule sets can be maintained, by the receipt of subsequent instances of data, information or other knowledge (Ciborra and Jelassi, 1994). In a similar manner, the success of one of the world's most dynamic mobile telecommunication companies, Nokia, has been based in some part to the understanding of form, function and interaction (Steinbock, 2001). Nokia have single-handedly managed to define a desirable and definable standard for information navigation, most visible when enabling the device features. In this case, the symbolic or sign-based (semiotic) relationship through the interface with the user is based upon a limited wordset vocabulary hierarchy : key menu items such as "Messages", "Settings", "Services" being supplemented with at most a sub-menu hierarchy of upto 6 selectable options, for example "Inbox", "Phone Settings", "Voicemail Settings". The causal/relational (symbiotic) effect produced by interacting with this device is inherently linked to the semiotic representation of the functions available in the phone: if the menu options are represented with stylized yet instantly recognizable symbols and wording, the interaction behaviour will also similarly follow, through a much deeper understanding of the workings of the mobile phone. Thus, it is becoming apparent that the real benefits of exploiting technology, exists in understanding the semiotic and symbiotic aspects of human interaction, whilst also defining and architecting knowledge constructs which allow users to interact more naturally with information. Extending the foregoing notions further, a model to define the nature of the semiotic and symbiotic nature is now presented in Figure 2, which provides context to both concepts.

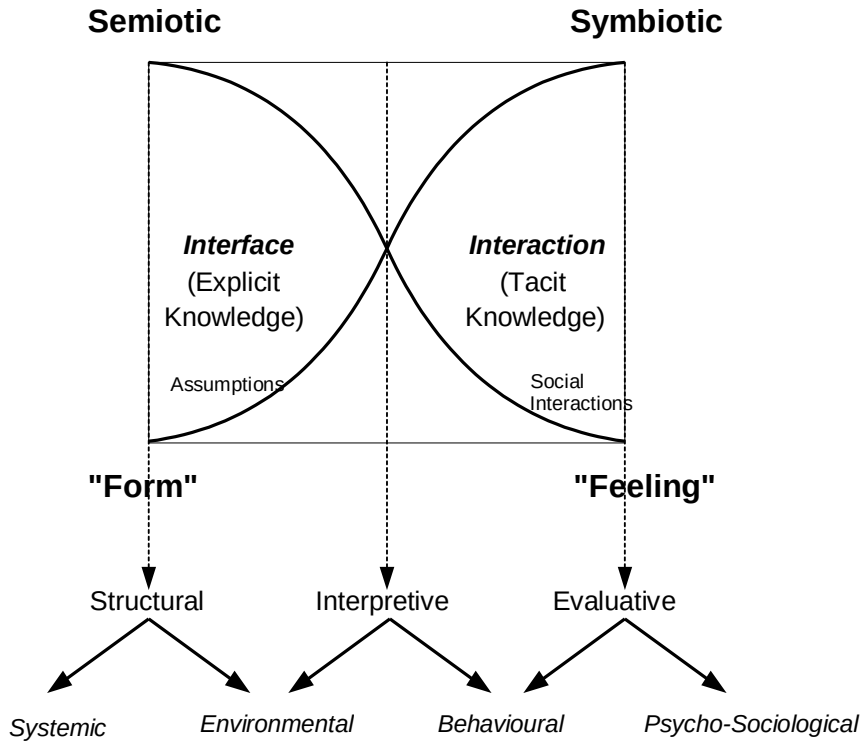

Figure 2. Mapping interface and interaction: Semiotic and Symbiotic effects

The basis for this model is as follows. Essentially the development of any knowledge-based information system relies upon the effective realization of a user interface (a method for manipulating knowledge); a knowledge context (a structure for mapping knowledge); and a navigation standard (a process or technique for navigating knowledge). Where concepts of semiotics and symbiotics come into play, is in understanding the interface between these three states. Issues of usability and interface, can be thought of as being symbiotic in nature (the relationship with the interface), and navigability can be thought of as being semiotic (the grammar of navigability, for instance), whilst contextuality can co-exist in both states.

The author suggests in the diagram in Figure 2, that the transition between Semiotic and Symbiotic states consist of aspects of the interface and the interaction between "form" and "feeling" (i.e. a transition between Structural through to Evaluative knowledge; Sharif and Irani, 2004). This is shown in the diagram, as the curve rising from the bottom left of the rectangle to the top right and the curve falling from the top left to the bottom right of the rectangle, respectively. The curves shown in this diagram attempt to highlight the non-linear nature of the transformation, or rather reliance, of explicit knowledge on tacit knowledge (and vice-versa). Contextuality is inferred in this diagram in the sense of Nonaka and Takeuchi's concept of "Ba" or place of being. In other words, knowledge cannot exist without some context and cannot be transmuted into human action, without a transformation between the unknown and known (Nonaka and Takeuchi, 1995), which is implied by the legend Structural, Interpretive and Evaluative at the bottom of the diagram. Also, this diagram attempts to pay homage to those schools of design who view knowledge as not only being a sign of the existence of some information construct and its related significance (Barthes, 1998), but also a representation of a relationship with the knowledge artefact (Anthes, 2001; Sowa, 2000). The overlap between the curves is therefore a transmutation point where knowledge has some particular contextual significance (Heylighen, 1990), knowledge being generated in some part due to an autopoeitic or self-organising

nature (Merali, 2002), as a result of interaction between both explicit and tacit forms (the left and right hand side of the diagram respectively).

This mapping therefore seeks to reinforce the notion of context as being part of the interaction between the structure of information (the Semiotic) and the method by which information is related and consumed (the Symbiotic). This means interaction with information should not only be reliant upon codified and Semiotic knowledge (e.g. spreadsheets and documents held in a knowledge repository database), but also reliant upon the Symbiotic relationship associated with it (e.g. usefulness and relevance of knowledge to a particular task). Hence by placing Structural, Interpretive and Evaluative forms of knowledge along this continuum therefore, the author presents the fact that there may exist a very wide range of features and characteristics which can inhibit and accelerate, the adoption and usage of knowledge within individuals and organizations (i.e. from explicit to tacit knowledge). In terms of the organizational IS aspect, knowledge workers typically expect both breadth of information, as well as depth (KPMG, 1999). By introducing a (semiotic) context and relevancy of that information alongside a multiplicity of (symbiotic) associations between data sources and content, a more effective realization of the concept of managing knowledge can be grasped. That is to say, by incorporating the use as well as the basis for knowledge, should allow a greater appreciation of its use and importance within an organization (as noted by Nonaka and Takeuchi, 1995). In order to extend these notions of representational and relational knowledge structures, we will now consider the development of a conceptual framework that provides a further insight into these notions.

3 DEVELOPING A CONCEPTUAL KNOWLEDGE STRUCTURE / CAUSALITY FRAMEWORK: TAPE

The thesis presented so far, has primarily dealt with understanding the fact that there should be equal importance given to both the contextual representation (semiotic) and causal relationship (symbiotic), as given to the consumer / stakeholder of that knowledge. A four stage conceptual approach is now proposed in order to understand the requirements for representing and providing access to knowledge better, based upon the semiotic and symbiotic aspects defined above.

3.1 Explicit-Tacit knowledge transfer drivers

The author contends that the focus needs to turn to the manner by which these concepts are actually adopted and recognised, both behaviourally, psychologically and sociologically, between and within individuals. Tacit knowledge is attributable to being an individual's knowledge, which cannot be easily articulated, in the sense that this type of knowledge relies upon specific recognition variables, only known to the individual. In their work on the subject, Järvenpää and Immonen, also conclude this theory. They state that in some aspects, knowledge intensive work does seem to require significant cognitive information processing capability, in order to guide work in order to manipulate and communicate symbols effectively (Järvenpää and Immonen, 1998). This is perhaps one of only a handful of potential reasons for the reasons behind tacit-explicit knowledge transfer. Zack (1999) expands upon these ideas by suggesting that a consensus needs to be reached by both individuals and the organisation about what knowledge is made explicit and what is left as tacit. Bhatt (2000) qualifies this even further by suggesting that different knowledge development lifecycles should be used to distinguish between knowledge held by organisations as distinct from knowledge held by individuals. In each of these cases, then, it therefore becomes possible to highlight the distinguishing features of explicit and tacit knowledge. This can be via the four key knowledge aspects of the knowledge transfer process, which the author has recast via the characteristic aspect of philosophical, behavioural, sociological and psychological drivers, as shown in Table 1.

Knowledge Aspect	Fundamental Driver	Realisation
Creation and Transfer (Socialisation)	Environmental	Context of Information within an IS : the epistemological and phenomenological cause for the existence of knowledge
Realisation (Externalisation)	Psycho-sociological	Alignment to core Business Processes: making sure that knowledge "fits" and is pertinent to the individual and the organisation
Distribution (Combination)	Systematic	Development of knowledge tools and processes within IT: providing a systems and support infrastructure, to allow individuals to share and access knowledge
Operationalisation (Internalisation)	Behavioural	Tactical usage of knowledge: learning from and adapting available knowledge (i.e. knowledge re-transformation)

Table 1. Explicit-Tacit aspects based upon the SECI model (Sharif, 2004)

The factors within this table, define a mapping between philosophical, behavioural, systematic, and psycho-sociological drivers, via the previous discourse on the research in this area. Thus, the experience and insight into the creation and transfer of explicit and tacit knowledge, shows that the main focus of mapping knowledge to business process tasks, lie with understanding the psychological and physiological context of information use. This is a natural progression of the concepts of Structural, Interpretive and Evaluative forms of knowledge previously discussed (Sharif, 2004). Through including not only the "what" (in terms of information content), but also the "why" and "how" (in terms of the psycho-sociological context), the models of knowledge transfer suggested by Polanyi (1966) and Nonaka and Takeuchi (1995), are more in tune with those implicit, indirect factors which drive knowledge use. Hence, it is now becoming apparent, that the reasons that necessitate the usage of knowledge are inherently dependent upon a few key factors: (i) Knowledge must be definable, in some sense (structural, interpretive, evaluative); (ii) it must be available to both the individual and collective; and (iii) it must be either definable (explicit) or unknown (tacit). Underlying these aspects, there must also be some contextual modifier which allows knowledge to be relevant to a situation – there must also be some behavioural, sociological or psychological drivers which determine just how tacit or explicit, knowledge is.

Experience and research suggests that information systems and information technology alone, does not for the capture of all aspects and connotations of knowledge, in this regard. Indeed, as it has been shown, current approaches to knowledge integration within companies, are more infrastructure-based (i.e. IT) than people-based (i.e. IS). This particular characteristic, further distinguishes the notion of IS being different to IT, and as such, the novel framework shown in Figure 2, is derived by the author from the previous issues and concepts presented in Table 1. To recap, each of these concepts relates to the SECI model, in terms of Environmental (Socialisation), Psycho-Sociological (Externalisation), Systematic (Combination) and Behavioural (Internalisation) factors. By recapitulating and aligning these core SECI factors within the authors' interpretation of them in this light, Figure 2 shows that the contributing factors to explicit and tacit knowledge, are essentially drivers for the transformation between these two states. This figure also shows that although knowledge can be defined generally in terms of its relation to data and information, there are more subtle factors which pertain to the social as well as psychological importance of knowledge use.

Attempting to contextualise knowledge within an organisation via a systematic approach (i.e. both socialisation and externalisation cannot be carried out alone, if the dependencies upon these two aspects of Nonaka and Takeuchi's model are to be considered). These factors have to be related to each other as this is part of the explicit – tacit approach taken by the aforementioned researchers (the idea to which many practitioners and academics subscribe to, but don't extend their models and

theories towards). Therefore a mapping between these aspects (i.e. the top of Figure 2) and the underlying factors of operational (internalised behaviour) and realisable (combined psycho-sociological) factors (i.e. the bottom of Figure 2), must also be considered. In other words, to use and represent knowledge effectively, an understanding of the human dimension is required (and not just the procedural or environmental causes for it). This is another reason why understanding how and where knowledge is used within organisations is a complicated matter: the inter-dependencies between these four factors outlined within this transformation model, have been very rarely, if at all, discussed within the literature.

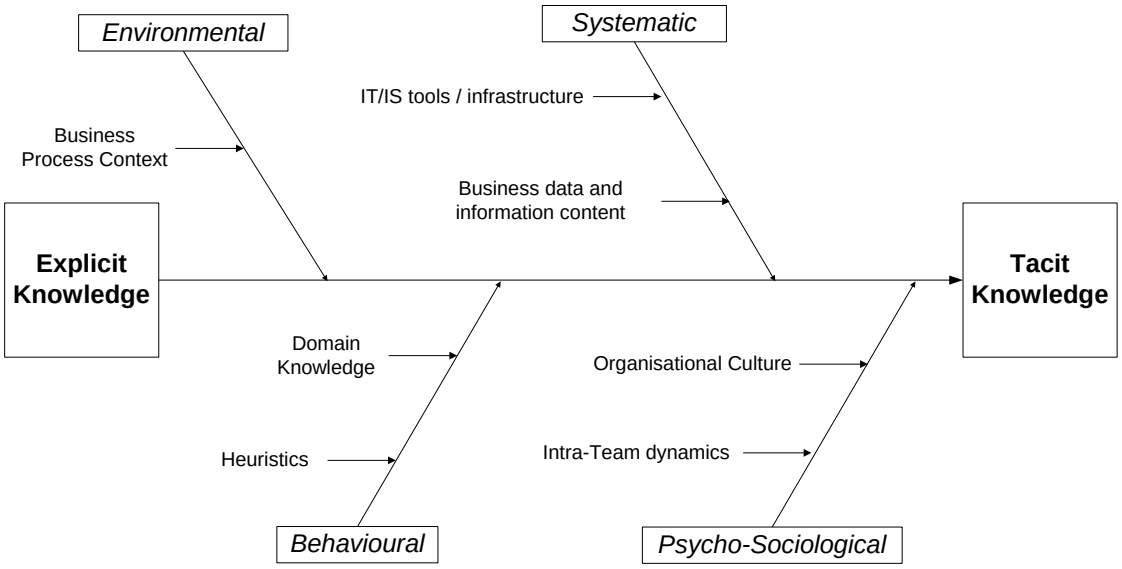

Figure 2. A framework for Explicit-Tacit knowledge transformation drivers (Sharif, 2004)

3.2 The TAPE frame-of-reference

The author now proposes highlighting specific components of this organisational-centric view, as well as the specific Semiotic and Symbiotic stance taken earlier. The author presents a mapping via those characteristics Technology, Accessibility, Psychology and Enforceability within Figure 3. This figure shows the TAPE frame-of-reference in relation to those components of a knowledge transformation framework shown in Figure 2 and Table 1 (namely aspects of Environmental, Systemic, Behavioural and Psycho-Sociological drivers).

Essentially the development of the TAPE frame-of-reference relies upon this. As such, in terms of the first of these characteristics, using current information technologies, it is not unfeasible to produce tools, techniques and services that allow both mappings between Semiotic and Symbiotic knowledge sources, as well as mechanisms for the interpretation of such information. The appropriate use of technologies as diverse as intelligent agents / avatars, thematic community knowledge repositories, content management delivery platforms, expert systems and contextual search engines is a necessary step in allowing knowledge to be used, based upon causal relationships and relevancy to particular knowledge tasks. Secondly, in terms of the Accessibility component, in order to map the extent of knowledge in an organisation, the output of any knowledge management-based process, should be to also monitor and report on usage trends of that knowledge. In other words, does, for example, the generation of working papers in a university department depend more on the revision of existing knowledge, or the discovery of new ideas?

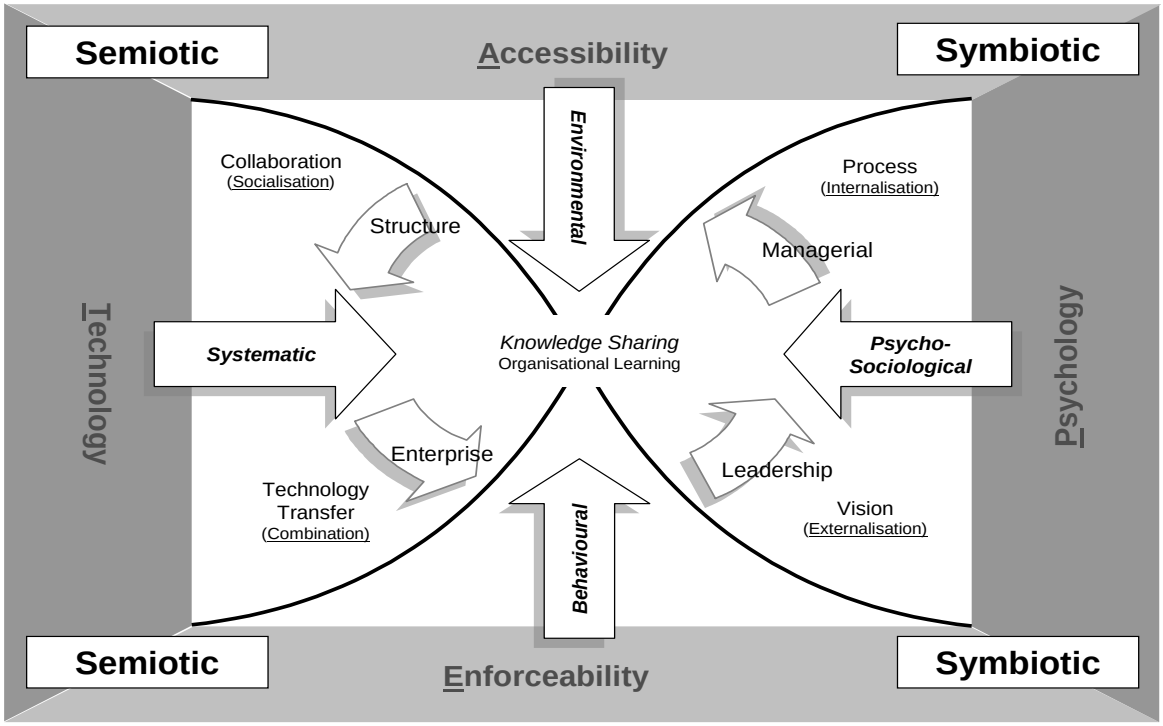

Figure 3: The TAPE framework

Fundamentally, this will also help to define the depth of knowledge culture and the effect that Semiotic and Symbiotic interaction has on modifying and altering stored information. Thirdly, organisations and individuals, need to define and understand the best interaction methods for certain types of knowledge and map them accordingly : for example, is it more realistic to provide access to documents and reports within a knowledge repository based upon structure and hierarchy (a semiotic approach), or based upon relevancy to a knowledge worker's business process (a symbiotic approach)? This encompasses the third characteristic, that of the Psychological aspect. Finally, organisations need to investigate shifting the emphasis from the storage of knowledge to better approaches for knowledge retrieval. This concept manifests itself through the design of information hierarchies and architectures (much like how libraries organise books), in order to access information and knowledge in the most efficient and intuitive way possible. Through doing this, the usage behaviour and interaction with knowledge can be enforced. Further, these four key enablers (henceforth known through the acronym, TAPE) can be put in the context of a traditional knowledge management strategy: identifying the most relevant knowledge pertinent to a task and understanding the appropriate usage for it.

The components shown typically revolve around a largely structural or organisational aspect, whereby changes to both representation (knowledge sharing and structure), creation (entrepreneurship or enterprise), and processes (managerial and leadership) are required. Where the components of the TAPE frame-of-reference are introduced into this strategy, then the inherent inter-relationships between structure, context, interaction and inference are more clearly discernable, through the introduction of a language and relationship schema for the required knowledge. The use of a semiotic as well as a symbiotic frame of reference to a particular source of knowledge appears to be a more pragmatic way to represent and understand knowledge.

The codification of knowledge and its resulting taxonomical categorisation should be considered as part of a holistic view of organisational knowledge requirement needs and processes. By considering the effects of the relationship between consumers of information and that of the usage of knowledge, the author suggests that the advantage of introducing a Semiotic and Symbiotic view of explicit and tacit knowledge, improves our understanding of the interplay between the known and unknown factors

which drive knowledge representation and use. Those aspects of Nonaka and Takeuchi's SECI model within the context of both Semiotic (i.e. explicit) and Symbiotic (i.e. tacit) knowledge need to be also borne in mind. In such a way the TAPE frame-of-reference so derived by the author provides a holistic interpretation of these fundamental aspects of knowledge, and allows for an interpretation of both the human, social and technological facets of decision-making behaviour. Thus, the TAPE frame-of-reference can be used in order to understand the interplay between all of these knowledge components, and can potentially also serve as a tool for assessing and analyzing the scope and impact of IS organisational change, through the mapping of stakeholders and their interactions with processes and technology.

4 CONCLUSIONS

This paper has discussed issues of semiotics and symbiotics in relation to knowledge-based information systems, by seeking to further understand the modalities present in the human-technology interface, as well as refining the relationship between the knowledge and interaction aspects of the TAPE framework proposed, in order to bring these disparate concepts together. However, the question naturally arises as to how to implement such an approach given the preceding definitions and concepts raised so far. It is well understood that the traditional notion of knowledge management, consists of a series of approaches to leverage the sharing, creation, approval and deployment of knowledge within an organization. As Earl (1995) and Sveiby (2001) and many others in the field have repeatedly noted, there are at least four core components to this concept: knowledge systems; networks of knowledge communities; a learning organization which is amenable to continuous change. What these comparable processes lack however, is the semiotic and symbiotic dimension discussed in this paper. Whilst many knowledge management implementations have succeeded in highlighting learning organization (in) efficiencies and realizing the worth of explicit and tacit knowledge (Davenport and Prusak, 1998; Nonaka and Takeuchi, 1995; Von Krogh et al., 1999), such approaches so far have been limited to codification and representation issues. This is in the sense of finding acceptable strategies for creative as well as ingrained organizational information that requires greater distribution amongst co-workers.

Kluge et al. (2001), define some of these aspects in terms of an evaluative framework (the knowledge management 'scanner'), which encompasses notions of transferability, perishability and spontaneity (to name but a few). However, these considerations still attempt to deal with a situation where existing or newly generated knowledge is meant to be classified according to some form of classification grammar. This is of course, a knowledge context, but in its loosest sense. The TAPE approach proposed on the other hand, instead takes the view that codification of knowledge and its resulting taxonomical categorization, should only be considered a part of a holistic knowledge management approach. By also considering the effects of the relationship consumers of information have on that knowledge, we can begin to consider the advantages of introducing semiotics and symbiotics into the process. This is best embodied in the concept of pervasive technologies, technologies and systems which are simultaneously part of form and function. Another issue that is raised in discussing the interface between the symbolism of knowledge and the causal relationship users have to it, is to do with the applicative aspect of knowledge use: where and when does information transmute into knowledge and what is the interface that supports it? Moreover, the ontological perspective of the interaction needs to be placed in context also. This is based upon the knowledge task that is being carried out: fact-finding, browsing, collaborating, problem solving or decision-making. Hence, there is a need for developing holistic, evaluative methods for classifying information and knowledge and the protocols of access, which underpin the concepts of semiotic and symbiotic knowledge discussed already. Codification issues aside, there needs to be further research and investigation into methods by which causal (symbiotic) relationships to knowledge held in information systems, can be inferred. Also, given that appropriate interfaces to (semiotic) structures can be put into place, the representation

of knowledge will still be a highly subjective and context specific tasks. Therefore, it is even more important to gain a greater understanding and meaning of these key factors discussed in this paper. In conclusion, the investigation of these concepts as discussed has an implication to the implementation of information and knowledge management systems within and across organisations. The TAPE framework as shown, attempts to suggest that in order to extract meaning and usefulness from such constructs, the overlap between semiotic (technology and accessibility) and symbiotic (psycho-sociological and environmental) needs to be taken into account. This framework can then be used in order to understand this interplay between and all of these knowledge components, and can potentially also serve as a tool for assessing and analyzing the scope and impact of IS organisational change, through the mapping of stakeholders and their interactions with processes and technology.

References

Anthes, G. H. (2001). *Symbiotic Intelligence*. Available [On-line, October 2001]. http://www.computerworld.com/managementtopics/management/story/0,10801,64912,00.html

Badii, A., and Sharif, A.M. (2002). Enterprise Challenges: Information Management, Knowledge Integration & Deployment . In *Proc. International Conference on Systems Thinking in Management 2002 (ICSTM 2002)*, Salford University, UK.

Barthes, R. (1988). *The Semiotic Challenge*. Hill and Wang, New York.

Bhatt, G. D. (2000). Organizing knowledge in the knowledge development lifecycle. *Journal of Knowledge Management*, 4 (1) : 15 – 26.

Ciborra, C., and Jelassi, T. (1994). Knowledge as Strategy. In (M.J. Earl, Ed.). *Strategic Information Systems – A European Perspective*. Wiley, New York.

Cooper, A. (1995). *About Face : The Essentials of User Interface Design*. John Wiley and Sons.

Davenport, T. H. and L. Prusak (1998). *Working knowledge : how organizations manage what they know*. Boston, Mass, Harvard Business School Press.

Earl, M. J. (1995). Strategic Information Systems – A European Perspective. Wiley, New York.

Gupta, U. (1996). Management Information Systems: a managerial perspective. West Publishing.

Heylighen F. (1990). *Representation and Change. A Metarepresentational Framework for the Foundations of Physical and Cognitive Science*, (Communication & Cognition, Ghent, Belgium).

Järvenpää, E. and Immonen, S. (1998) Quality of working life in knowledge and information work: Implications for information society. In (Eds. P. Vink, E.A. P. Konigsveld and S. Dhondt). *Human factors in organizational design and management – VI*. Elsevier : Amsterdam, Netherlands.

Kluge, J., Stein, W., and Licht, T. (2001). *Knowledge Unplugged*. Palgrave, Basingstoke.

Kock, N., and McQueen, R. (1998). Knowledge and information communication in organizations – an analysis of core, support and improvement processes. *Journal of Knowledge and Process Management*, 5 (1).

KPMG (1998). *The Knowledge Journey – A business guide to Knowledge Systems*. KPMG Consulting, UK.

Leonard-Barton, D. (1995). Wellsprings of Knowledge : Building and Sustaining the sources of Innovation. Harvard Business School Press : Boston, MA, USA.

Merali, Y. (2002). The role of boundaries in knowledge processes. *Eurpoean Journal of Information Systems*, 11 : 47 – 60.

Nonaka, I., and Takeuchi, H. (1995). *The Knowledge-creating company*. Oxford University Press.

Polanyi, M. (1966). The Logic of Tacit Inference. *Philosophy*, 41 (1): 1–18.

Scherer, E. (2000). The knowledge network: knowledge generation during implementation of application software packages. *Logistics Information Management*, 13 (4) : 210 – 217.

Sharif, A. M. (2002a). The Logistics of Information Management. *Logistics Information Management*, 15 (1/22) : 76-79.

Sharif, A. M. (2002b). Professional Services Organisations and the role of Consulting in the New Economy. *Information Systems Management*, 19 (2) : 19-30.

Sharif, A.M. (2004). *Knowledge representation within Information Systems in Manufacturing Environments*. PhD dissertation, Department of Information Systems and Computing, Brunel University, UK, May 2004.

Sharif, A.M., and Irani, Z. (2004). Representing Knowledge within Information Systems: A Taxonomy. In (Ed. Z. Irani). *Proc. European and Mediterranean Conference on Information Systems 2004 (EMCIS 04)*, 25th – 27th July 2004, Tunis, Tunisia. [CD-ROM proceedings].

Sorensen, C., and Kakihara, M. (2002). Knowledge Discourses and Interaction Technology. Department of Information Systems Working paper 115, London School of Economics and Political Science, London, UK.

Sowa, J.F. (2000). *Knowledge Representation : Logical, Philosophical, and Computational Foundations*, Pacific Grove, California, Brooks/Cole.

Steinbock, D. (2001). *The Nokia Revolution*. Amacom.

Sveiby, K.-E. (2001). A knowledge-based theory of the firm to guide in strategy formulation. *Journal of Intellectual Capital*, 2 (4): 344-358.

Syed, J.R. (1998). An adaptive framework for knowledge work. *Journal of Knowledge Management*, **2** (2) : 59 – 69.

Von Krogh, G., Ichijo, K., and Nonaka, I. (1999). *Enabling Knowledge Creation : How to Unlock the mystery of Tacit Knowledge and Release the power of Innovation*. Oxford University Press, NY.

Wilson, J. (1994). Information Management. In (J. Feather and P. Sturgess, Eds). *Encyclopaedia of Library Information*. Routledge, London.

Zack M. (1999) Managing Codified Knowledge. *Sloan Management Review*, Summer, 45-58.