Information Systems Frontiers 3:2, 227–238, 2001

Effective Knowledge Management: Knowledge, Thinking and the Personal–Corporate Knowledge Nexus Problem

Steve Benson and Craig Standing*
School of Management Information Systems, Faculty of Business and Public Management, Edith Cowan University, 100, Joondalup Drive, Joondalup, Western Australia
E-mail: s.benson@cowan.edu.au
E-mail: c.standing@cowan.edu.au

Abstract. *We argue that the intimate relationship between computer architecture and software has produced a professional mindset that is unsuited to the newer, knowledge-based business paradigms. Major software projects are ending in failure or do not yield their maximum potential and we suggest reasons why this is the case. In conclusion, we propose that Management Information Systems Curricula need to be revised to provide students with exposure to and practice in a variety of thinking styles. Organisations must change their structures and management styles if they are serious about managing knowledge. In making our case we briefly review the development of information systems as a discipline and the role of methodologies in the articulation of its paradigm. We end our paper with suggestions for future research.*

Key Words. *information systems, knowledge management, thinking styles, IS failures*

Introduction

In this paper we argue that the discipline of Information Systems is ill equipped to deal with some of the challenges related to the increasing interest being shown in knowledge management and related areas. This is to a large extent due to the early focus of the discipline being constrained by aspects of machine architecture and a bottom-up approach to software development.

We start with a brief overview of the some of the formative principles of the information systems discipline. A small study of IS practitioners is used to propose that even senior professionals seem to have idiosyncratic methods of solving problems. We then explore the literature on alternative thinking styles and how these can usefully be employed by those in the IS profession, especially in the area of knowledge management. Finally, after a brief introduction to knowledge classifications, the paper provides some suggestions for organisations wishing to develop knowledge management systems.

The Beginnings of Information Systems

By the early 1970's Information Systems appeared in the curriculum of several American universities. A question that needs to be asked is whether the inclusion of a subject in university curricula qualifies it as a "discipline". In Banville and Landry's (1989) "monistic view of science" the boundaries of science are usually clear, there is usually a paradigm (system of working) and an infrastructure (journals, committees etc.) that provide coherence. The more mature the paradigm the higher the level of coherence and the better defined the discipline. For pure sciences the paradigms are well established and reasonably easy to articulate. For social sciences, education, psychology etc. the paradigms are not well defined, indeed part of the paradigm is to seek to define the paradigm. Such a high level of self-reference actively prevents a high degree of coherence resulting in divergence and differentiation-schools of thought within the discipline. The reward systems of academia ensures that specialisation and conflict are in the best interests of academics. If there were to be agreement on the true nature of Information Systems many would find the mind shift too much to bear. It seems resistance is not futile in this context.

*To whom correspondence should be addressed.

After John Dearden (1972) of the Harvard Business School wrote "Management Information Systems is embedded in a mish-mash of fuzzy thinking and incomprehensible jargon" there was an outcry from academia and industry. The most notable reaction was a sudden quest for respectability as journals and conferences intended to promote credible research and scholarship began to emerge. At the first ICIS conference, Keen (1980) suggested mirroring research methods from more established disciplines such as economics and behavioural science. Over the next decade research methods became more important than the subject of the research and any topic loosely associated with the emerging field of business computing was a legitimate research subject.

In the 1960's computer systems began to be used for truly commercial purposes, prior to that time they had been used in science and engineering as the first wave of the information revolution (Hutchinson, 1996). Just as the industrial revolution extended our physical capabilities, so the information revolution extended our mental capabilities. Initally in the area of calculation as problems which would take a human a lifetime to solve could be handled by a computer on a timescale that was almost immediate. From here it was short step to using computers to access, process and filter huge quantities of data. This did not produce knowledge or give insight, but simply allowed mundane tasks to be automated and interesting questions to be raised and (potentially) answered. Many of the scientists and engineers who had worked in computer science fields moved into information related activities, bringing with them a mindset that was rigorous, logical and grounded in mathematical notation. The development of jargon is an essential part of any discipline, not merely as a means of shorthand communication but as a means of maintaining the secrecy of discipline specific knowledge. By the 1970's the jargon was well established and was one of the areas in the field where there was broad consensus.

Churchman (1994) advocates a new approach for management science. He argued that after all the effort put into mathematical modelling, management science has still to provide effective problem solving methods. This perhaps highlights a lack of practical problem solving approaches by most practitioners or it maybe that many methodologies are seen as impractical.

Technological development outstripped the ability of most practitioners to keep pace and there was little by way of conceptual frameworks to help them. Success lay in reductionist approaches, reducing complexity and diversity to manageable proportions and using simplistic methodologies to produce "adequate" systems. By the 1990's software development tools and project management tools had improved dramatically. The complexity of systems increased enormously and many methodologies were developed and marketed as "total system solutions". However, despite these developments few completed systems yielded anything like their full potential (Beynon-Davies, 1998). To understand why this should be the case we need to consider the evolution of information systems thinking in the context of socio-technical developments.

The VonNeumann Bottleneck

John VonNeumann defined the architecture of the modern computer and the simple fetch-execute cycle defines its operation. A single processor handled everything and data and program instructions all passed through it. This imposed a physical bottleneck since it imposed sequence and denied parallelism in the execution of software. Portable languages such as COBOL, FORTRAN and LISP were developed, giving some degree of abstraction from machine architecture, but in practice the VonNeumann bottleneck also imposed a conceptual bottleneck on programmers since high level code was parsed left to right, top to bottom which imposed sequencing. Thus programmers were required to think one dimensionally (sequentially) and design methodologies of that time (flowcharts) reflect that. However if we consider a typical high level language then we may make a distinction between programming statements and programming expressions. A programming expression occurs to the right of an equals sign, it has good mathematical properties and is amenable to reason. A programming expression occurs everywhere else in executable lines of code, it has no useful mathematical properties and is essentially chaotic in nature (Darlington, 1980).

First and second generation programming languages were concerned with sequence and were very low level. The programmers' views were purely one dimensional and the flow chart was their preferred methodology. Third generation languages supported structures and the design methodologies were "architectural' in nature, representing sequence and hierarchy. While these methodologies reduced complexity and diversity in their representation of systems, they

largely ignored complexities of implementation. Purists insisted on balanced structure diagrams, convinced that if the design looked nice it would perform well. Some of this may have been to develop notations that would assist in the quest for credibility of the discipline and in retrospect it seems that practitioners borrowed from architecture and engineering to achieve this end. There was little influence exerted on Information Systems by philosophy per se though there were examples of selective borrowing. David Warren's work in PROLOG (Logic programming, see Darlington (1980) and Cliff Jones' work on VDM would have met with Bertrand Russell's approval. However Jones' (1986) work neglected the simple fact the process of reification of a program involved exposing it to the vagaries of local language semantics, no matter pure and logically robust its specification might be. Additionally the notation was so difficult that most practitioners did not adopt it.

Structured Programming and Design paradigms (Beynon-Davies, 1998) were at best, an attempt to impose order on the world of programming statements. This bottom-up (detailed) approach and focus on the detail of software development led to considerable distortion in terms of how information systems as a discipline should be viewed. The fusion of ends and means has continued to dominate information systems thinking for four decades and in our view, is responsible for many of the discipline's shortcomings.

What do Information Systems Practitioners Understand About Information, Knowledge and Methodologies?

It seemed intuitive to us that practitioners should be capable of performing situational analysis and problem solving in an adaptable manner. Further, we thought that it would be necessary to make a distinction between knowledge and information to be effective. The question "how do people decide which methodology to employ?". We interviewed eight information systems practitioners, each with a minimum of five years experience. We have no delusions about the academic rigour of such a small sample size, our intention was to identify directions for future, more properly constructed research. However the preliminary results were sufficiently interesting to merit a mention here. Firstly we discovered that here was an overwhelming naive realistic assumption that equated knowledge with information and treated them in the same way. Only one interviewee had had any exposure to concepts such as constructivism and only two made any distinction between knowledge and information.

We asked about methodologies and there was strong consensus as to the meaning of the term, we were interested in the way that people used methodologies and so asked the interviewees how they approached a situational analysis for a system. Six of the eight said that they approached the problem with a methodology in mind, only two considered the situation first and then chose a methodology. This was not what we expected, we had thought that practitioners would have a range of methodologies or thinking styles which coexisted in a state of dialectical tension, a methodology being adopted when the practitioner thought it was a good fit. This suggested that we check other authors' work.

Lyytinen (1985) argued that problem solving approaches are framed by the language style or paradigm of the analyst. He used five language views: denotational, generative, cognitive, behaviourist and interactionist to argue his case.

Keinholz (1999) states that Harrison and Bramson (1999) identify five main modes of thinking which are typified by the following philosophers: Hegel, Kant, Singer, Liebniz and Locke. A distinction can be made between the substantive/value oriented thinking and knowing styles (represented above by the Hegelian and Kantian modes) and the analytical/realist style (represented by the Liebnizian and Lockeian modes) which are characterised by their factual/functional approaches. Singerian thinkers are not so easily classified. Harrison and Bramson (1999) found that approximately 50% of people prefer to think in a single style, 35% will combine two or more styles. The survey (Harrison and Bramson, 1999) of North Americans provides the following results (Table 1).

Table 1. *A survey of thinking styles (Harrison and Bramson, 1999)*

Thinking styles	% of respondents
Idealist (Kantian)	+37
Analyst (Liebnizian)	35
Realist (Lockeian)	24
Pragmatist (Singerian)	18
Synthesist (Hegelian)	11
Preferring four or more of the above equally	13

The Synthesist and Idealist inquiry modes are substantive, value oriented ways of thinking and knowing, while the Analyst and Realist are functional and fact oriented. While about half of all people prefer to think in one main way, 35% prefer two or more styles in combination. Most people in North America prefer the Idealist style (+37%), followed by the Analyst (35%), the Realist (24%), the Pragmatist (18%), and the Synthesist (11%). Thirteen percent have a level profile where four or five of the styles are preferred fairly equally (Harrison and Bramson, 1999). Further work is required to see whether the versatile 13% above are more effective in complex problem solving situations. We believe the results cited above are rigorous and tend to support our own findings.

Why do Practitioners Think that Projects Succeed and/or Fail?

For us this was the most significant question, we had expected that methodologies would not be blamed for failure given the technical background of the interviewees and their responses to earlier questions. Blame was attributed to cutting corners, unrealistic timelines, insufficient rigour. Perhaps the most revealing comment was that "there was nothing wrong with the system, the users were just too stupid to use it properly".

If methodologies were not responsible for project failure, we expected interviewees to properly acknowledge their part in successful projects. To our surprise methodologies were hardly mentioned. All but one of the interviewees attributed success to close interaction with users, "making targets visible" was one expression. Maximising shared understanding would seem to be a recipe for success and this did not seem to be compatible with the objectivist approaches that our interviewees recommended. (Gilb, 1987) attributes project failures to slaveish adherence to methodologies and overcommitment to planning.

Educational research (e.g. Dewey, 1910; Ernest, 1995; Flavell, 1976) show that meta-cognitive abilities greatly assist in learning processes, i.e. an awareness of memory models and learning processes allows individuals to tailor their personal learning strategies more effectively. It follows that education and training in different thinking styles should enhance problem solving ability and allow for improved communication between staff since shared understanding should be increased. This would seem to offer a promising line of research. The question arises as to what should be taught, we propose a simple classification of thinking styles and a personal capability maturity model. Both of these are described.

A Simpler Classification

We believe Keinholz's (1999) presentation of Harrison and Bramson's (1999) view given above is too unwieldy for everyday use. The firm nature of the scheme also opens up the possibility for conflict. We believe that there is more advantage to be gained by focussing on commonality rather than difference. With this in mind we constructed the scheme below (Fig. 1).

In grounded positivism the researcher should investigate everything relevant to the situation under study, this is clearly impractical. Focussing on micro issues and ignoring historical aspects and pre-existing theories, grounded positivism (also referred to as grounded theory) assumes that theory will emerge from a study of collected data. Accuracy of description is vital. Thus, grounded positivism is primarily informational in nature.

For our purposes, Realism requires that a practitioner approaches a case study or situation with a theory in mind. Such theories are compatible with the practitioner's belief system(s). Alvesson (1996) suggests that "deep knowledge of the theory in use is preferable to shallow use of multiple theories". The actual theory used is of secondary importance due to the iterative

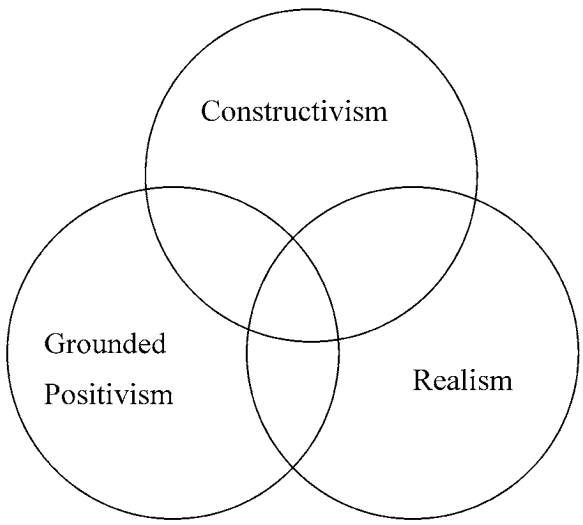

Fig. 1. *A simplified classification of thinking styles.*

nature of the subject. (This is reminiscent of Schon's (1983, p. 3) "The Reflective Practitioner" where Quist, an architect, insists "you must impose a discipline"). We see this as trivial knowledge.

Constructivism corresponds to internal or subjective realism in which reality is an inter-subjective construct, shared between individuals (social constructivism) or an individual construct. It is tempting to regard constructivism as purely subjective and postmodern in nature since it appears to deny the validity of reality. This is a common misunderstanding, and one of the great proponents of radical constructivism is at great pains to deny it (VonGlaserfeld, 1993). A second major criticism is that there is a multiplicity of views, which is the one true view of a situation? Plurality is allowable since individuals make best progress using their own internal constructions, i.e. are more productive with their personally constructed psychology (Kelly, 1955). Ernest (1995) does not deny the validity of a single view but implies that triangulation may yield a better result as a combination of views should produce a greater region of shared understanding. Our view is that practitioners should be able to move easily between the three principal styles identified above by cultivating an awareness of their thinking at a meta-level. However we need to identify the prevailing Information Systems Views or Models.

Information Systems Models

Following Weber (1997), it will be sufficient to consider three main views of Management Information Systems; Decomposition, Representational and State tracking.

- Decomposition: In this view a complex system is progressively broken down into subsystems of manageable complexity. There are rules and conventions regarding what may be termed a good decomposition but essentially the decomposition view typifies the "top down", structured approach i.e. a method of imposing order on understanding and design. There is a danger of losing system adaptability and responsiveness due to the tradeoff between the size of subsystems and the complexity of managing their development.
- Representational: the essence of the representational view is that of notation and grammar. A formalised method of describing systems which relies on two elements, a set of mappings from ontological constructs to grammatical constructs and a complementary set of mappings which perform the reverse function. While it is possible to demonstrate the completeness of a grammar, its clarity is a matter of subjectivity. The main difficulty here lies not with the grammar but with the ontological constructs. It is implicit in this view that the ontology is shared, it is the interplay of syntax and semantics (grammar and ontology) that defines the significance of the constructs. This leads into the age old debate between realists and relativists.
- State Tracking: here the view is that the information system will faithfully track events and changes in the subset of the real world of which it is an analogue. The problems with this view are complexity, chaos and the problem of information gathering. If changes in the real world subset tend toward chaos and instability then so must the information system. As the degree of complexity in the real world subset increases then so too must that of the information system. It is almost impossible to demonstrate that the information systems is complete and then the proof has time limited validity. In terms of reporting, it is implicit that real world events are reported objectively. Again, this leads us to the realist/relativist conflict.

Is There a Relationship Between Thinking Styles and Information Systems Models?

On first inspection there seems little apart from incidental coupling between thinking styles and information systems models. There is an element of realism that pervades every model but the other two styles do not appear to be present. It should be realised that the models are end views of a process i.e. outcomes, not processes. Personal maturity-capability is relevant here, while it is possible to give a mathematical description of a continuous learning curve, instead we propose a simple qualitative five-stage model (IPRAM), its stages are as follows:

- Inspirational—problem solving attempts are made with successes being relatively rare, toward the end of this phase others repeat successful attempts with no understanding of why they succeed.
- Pragmatic—problems are handled on the basis of experience and replication of things that have worked before, there is little theoretical framework.

- Rational—theories are developed on the basis of experience and tried and tested hypotheses.
- Anticipative—theories are used to predict outcomes and generate rules automatically.
- Mature—rules and theories have been accepted by staff and are used unquestioningly.

Grounded positivists will spend much of their time in the I & P stages, their level of relevant knowledge is relatively low. Realists have attained the R stage of our model and this we would regard as state of the art for the Information Systems discipline. The A & M stages characterise the constructivists and this is where the major productivity gains are to be made. A simpler framework might be to say that the I & P stages relate to "know what", the R stage relates to "know how" and the A & M stages relate to "know why". Again this would emphasise the confusion with means and ends in information systems. In addition to a personal metacognitive tool, the why-how-what framework provides a basis for deciding which activities within an organisation are suitable for productive automation. The more structured and less abstract the activity the more amenable it is to automation.

Drucker in his book *Post Capitalist Society* (1993) argues that we have passed through two discrete stages in the application of knowledge to wealth creation. The first of these was knowledge applied to "tools, processes and products" and played a substantial role in the rise of capitalism and the industrial revolution. The second stage is "knowledge applied to human work" i.e. the application of Taylor's scientific management theories to production. It may be argued that we are entering a third stage of wealth creating knowledge, "knowledge applied to knowledge" in which productivity depends on the activity of specialist knowledge workers. It is apparent that businesses which are able master organisational learning and knowledge management will enjoy sustainable competitive advantages over those which do not. If managers do not understand the nature of knowledge how can they manage it effectively?

The Nature of Knowledge

Attempts to classify thinking paradigms from a philosophical standpoint have been relatively successful. This is indicative of the maturity of philosophy as a discipline. By contrast the discipline of MIS is relatively new and there is only rough consensus as to what constitutes information and knowledge. Shannon and Weaver's (1997) work on information theory defines units for the measurement of information but no such metrics exist for knowledge. Instead it has proved necessary to adopt a pragmatic approach which implicitly measures knowledge by testing, either by means of professional examinations or performance in the field. There have been many attempts to devise a classification of knowledge which has practical implications (e.g. Collins, 1993; Fleck, 1997; Johnston 1988) gives an excellent discussion of several frameworks including that of Blackler (1988) who proposes five categories of knowledge

- Embrained—abstract knowledge dependent on conceptual and cognitive, often awarded superior status due to its association with scientific knowledge.
- Embodied—action oriented and usually only partly explicit, acquired in specific contexts and requiring face to face contact, sentient, tactile and other sensory inputs.
- Encultured—related to the process of achieving shared understanding and is embedded in cultural systems. Usually closely dependent on language for the mediation of social constructions.
- Embedded—residing in systematic routines and relying on the interplay of relationships and material resources, often embedded in technology, practices and explicit routines.
- Encoded—recorded in signs, symbols, books, electronic records etc. the process of encoding is that of distilling abstract codified knowledge from richer forms of knowledge.

Blackler (1988) proposes a 2×2 matrix to be used to establish which kind of knowledge is most important to an organisation (Table 2).

This would seem to be of academic interest only, most companies are well aware of the type of knowledge that is important to them, principally knowledge concerning, products and markets. The problem for most companies is one of knowledge management and sharing. While many authors in MIS are happy to acknowledge the distinction between knowledge and information (e.g. Dahlbom and Mathiassen, 1993; Hirscheim, Klein, and Lytinen, 1997) there those who refuse to acknowledge that division (Weber, 1997). It is likely that a significant portion of the MIS community holds the latter view. In our view there is a simple hierarchy, data are raw entries devoid of structure (e.g. entries in a spreadsheet); information is data processed

Table 2. *Knowledge relevant to organisations*

	Routine problem	Irregular problem
Individual effort	Expert dependent on embedded knowledge	Symbolic analyst dependent on embrained knowledge
Collective effort	Knowledge routinised, reliant on embedded knowledge	Communication intensive, reliant on encultured knowledge

in such a way as to make some emergent property visible (e.g. a graph of spreadsheet values) and knowledge is understanding the meaning of information.

Effective knowledge management requires a classification system that has distinctive classes, not so many as to be cognitively unwieldy nor so few as to be too coarse grained. We believe our three level model, expanded below, meets these criteria

1. Know Why: this is internally constructed, personal knowledge (VonGlaserfeld, 1993). This should not be confused with corporate strategy and mission statements, while these can be communicated to staff, meaning and motivation are personally scoped. As an example a senior manager's motivation may be to see the company succeed, an employee's motivation to do well may be the prospect of continued employment. The complex interplay of experience, belief systems and culture shapes personal knowledge construction. While there is scope for the establishment of consensual domains (Maturana, 1978) there seems little justification in investment in technology to support this— *unless that technology provides a rich medium for communication*. At this level organisational learning is engendered by social constructivism, the moderating means of that construction process is language (allowing that body language and gesture are intrinsic parts of language (Vygotsky, 1989)). Since e-mail and GroupWare are impoverished forms of communication, their deployment would actively conspire against the development of shared organisational knowledge.
2. Know How: it is necessary to subdivide this category into two parts. The higher of these is devoted to problem solving and is where cognitive skills, experience and intelligence are critical factors. While this knowledge is personally constructed there is scope for communicating it to others by reason of its domain specific nature. Intuitively there should be scope for increasing the productivity of staff engaged in this area by education and exposure to different thinking skills, i.e. enhancing meta-cognitive abilities (see below). Part of this requires social interaction, e.g. knowing which colleague has skills or controls resources required to solve a problem. Technology can make a difference here but only in terms of modelling, information processing capabilities and organisational abilities. Experience of underlying know how techniques and technologies is important e.g. how to mine the database, how to operate modelling packages etc. These underlying techniques are really trivial or catalogue knowledge and therefore belong to the next category.
3. Know What: this category represents trivial knowledge such as know what, low level know how, know where, know who i.e. well defined catalogue knowledge and processes. This category represents well defined areas of knowledge and as such justifies investment in technology.

This paper argues that it is the nexus of the *know why* and *know how* that represents the most productive area for effective organisational learning and knowledge management. How that nexus might be synergised is an important issue. The simple view is that the information systems is used and developed by staff. The very high-level knowledge remains personal while low level, trivial knowledge activities remain the province of the system. The gulf between the two is considerable. In a competitive industry such as Information Systems staff turnover is a problem with high costs associated with staff replacement (Tomes, 1999). Obviously we need to increase the shared knowledge between the organisation and the individuals. To achieve this we need to move from a point where the system supports the organisation to the point at which the organisation is the system and vice versa. Here we believe we may borrow from the social-constructivist, albeit in a hard edged, semiotic form, and seek to apply actor network theory.

Actor Network Theory

Actor Network Theory (ANT) emerges from the application of social sciences to technology. In addition to intrinsic motivation there are many factors that

influence the actions of an individual. If the example of driving a car is considered, there are traffic regulations, congestion, accidents, limitations on vehicle performance etc. that influence the driver's actions and curb actions such as speeding. The act of driving must be considered with all its influencing factors, forming an actor network. The driver's experience, personality type and intelligence are as much influencing factors as the technical characteristics of the vehicle, hence actor networks are heterogeneous. It should be realised that an "actor" need not be human, after all software may be regarded as a "role" for hardware to perform. If we consider knowledge management, then the key concepts we may draw from ANT are those of translation and inscription. Systems design should be seen as the act of translating apparent needs into a solution which is inscribed into the system. The inscription includes explicit programmes of actions for users and role definitions for the system and users. By inscribing a particular pattern onto technology, the technology then becomes an actor and imposes its inscribed actions onto its users. The process of inscription is cumulative; a single work routine may be inscribed into several system components. This superimposition and accumulation adds to the strength of the inscription. Latour (1991) gives an accessible example for teaching purposes, Hotels want guests to leave keys at the reception desk when leaving the hotel. Initially this was inscribed in the form of a notice at the reception desk asking guest to deposit their keys when leaving the hotel. This inscription was insufficiently strong. Next a manual doorkeeper was employed, this too failed. The next inscription was in the form of a weight attached to the key, by increasing the weight incrementally a point was reached at which the desired behaviour was imposed. This example is trivial and the socio-technical network it relates to is simple. Callon and Bell (1994) give an account of techno-economic networks which is complementary to Latour's model.

In ANT entities acquire attributes and take their form as a result of their interaction with other entities. Actor networks are formed by negotiation, enrolment of participants. Real business scenarios may have several actor networks which exist in states of co-operation, conflict or independence. In the case of conflict it is the strongest network which will come to dominate. As an example consider industry standards; VHS achieved market dominance over its technically superior and cheaper rival, Betamax; the DSK is little used in comparison to the "standard" QWERTY keyboard despite the improvement it offers in terms of efficiency. There are many other examples that will spring to the reader's mind.

Major Criticisms of Actor Network Theory

ANT is a hard edged, semiotic form of social constructivism and as such will not be appealing to a mind set that operates in an analytical-realist mode. A major criticism is that is almost impossible to define the boundaries of any actor network. This is usually accompanied by a critique of all subjectivist methods, i.e. there can be many accounts or views of a network, which single account is the true one? The response is essentially positivist in that an accurate description of any object is not necessary in order for that object to exist. Nor is it necessary (or possible) for all knowledge in a particular field to be known before useful work can be carried out in that field, physical and analytical chemistry were well advanced at a time when fewer than seventy elements were known. Also a single actant (human or hardware actor) may be claimed by many actor networks.

The Power of ANT lies in its qualitative expressiveness, an understanding of how actor networks operate may allow the creation of more "appropriate" networks and the deployment of effective change agents. Complications arise as the result of a single actor playing many parts, and many actors sharing a role. It is important to realise that the role has an existence which is independent of the actor. In all probability the role would continue to be performed if the actor were to leave or die.

If we consider the introduction of a new information system to an established business, experience shows that success of the new system depends upon the users. If the users do not fully accept the system then it will fail even if all its functional and quality attributes are correct. The difficulty is to ensure that our inscriptions are appropriate and sufficiently strong. For this example, we would identify key actants who then need to be persuaded that many of their problems will be solved by enrolling in the new network. Change agents such as trainers and facilitators actively recruit members, enlightened self-interest is a prime mover. Next the recruits' ties to old networks must be broken as the new network is formed, this tends to be a gradual process due to cognitive inertia. Obviously the new network must have a stronger identity than the

old network; pressure, inducements and simple consent are the means by which a strong network identity is achieved. Finally the network must represent absent and future members. The real key to success is motivation; all technical problems have a technical solution. For the purposes of this paper we are concerned with the personal-corporate knowledge nexus, our view has to be pluralist since we are considering the interaction of personally constructed knowledge and shared corporate understanding.

Personal-Corporate Knowledge Nexus

Most management approaches encourage workers to be selfish. Since the reward structures favour the able and the versatile and are competitive in nature, then it is not in a worker's interest to be altruistic and share knowledge. This represents a loss to the organisation. Bad knowledge practices become enculturated within organisations.

We have conducted a large study of knowledge management practices within a University with over fifteen hundred employees (Standing and Benson, 1999). The number one barrier to knowledge management and sharing was the competitive organisational form where employees were assessed on individual output. Most of those interviewed stated it was not in their best interests to share knowledge since a colleague could be in a better position to take advantage of it.

Discussion

This paper has been broad ranging but we will now attempt to draw the threads of our arguments together in a coherent form. We identify three key questions: (a) how to increase the productivity of knowledge creation on a personal basis? (b) how to facilitate the creation of organisational knowledge? and (c) how to manage knowledge resources within organisations? From our preliminary research and philosophical enquiry we are in a position to make the following observations as we address each in turn:

How to increase the productivity of knowledge creation on a personal basis?

While we would not have sufficient confidence in our preliminary research findings to quote percentages, we have found that there is a predominant naive realist assumption that equates information with knowledge. (Our pilot survey was carried out on a convenience sample of eight information systems practitioners, each with a minimum of five years experience). We also found that there is little or no distinction is made between different types of knowledge. With such a high degree of uncertainty we would not expect to find productive knowledge creation and management. We did find a compensatory mechanism in that our practitioners imposed a methodology to reduce complexity and diversity when considering a given situation. Usually, only a single methodology was employed. While we can offer no hard evidence to support our claim, it would seem likely that the capacity for creative or lateral thinking must be reduced by this approach and that opportunities are lost as a result. The pattern of thinking found seems to be mainly convergent.

We would suggest that education in meta-cognitive skills and thinking styles would give subjects a greater range of apparatus to choose from. Provided that their situational analysis is appropriate their solutions should be more effective. Further research is required to test this hypothesis. If the hypothesis is correct then there are profound implications for practitioners and MIS curricula. We selected a sample of 30 US universities which offered MIS courses and which had an on-line curriculum. While this is insufficiently rigorous to draw firm conclusions we failed to find one curriculum which addressed meta-cognition and thinking styles.

Awareness of the IPRAM model proposed above should enable subjects to reflect upon their own capability/maturity in a particular field and adjust their thinking style appropriately. While software interfaces have implications for productivity we would argue that most interfaces do not allow information to be organised in a manner that is intuitive to all users and find ourselves in agreement with Hartwick and Barki (1994) i.e. users must be able to adapt the interface to suit their own working style. One size does not fit all. It was recognised that opportunities existed to develop systems that could be used to aid in the acquisition, activation, retrieval, and application of knowledge in the eighties. For example, Hunt and Sanders (1986) presented guidelines for developing decision support systems to facilitate learning and innovation.

How to facilitate the creation of organisational knowledge?

This is where organisations stand to gain the most if effective solutions can be devised. In areas like MIS, there

is a high turnover of staff and this has deleterious effects on projects since so much knowledge and information leaves with a departing staff member. In this we suggest that Actor Network Theory has much to offer. We accept that there is natural suspicion on the part of many MIS professionals toward "soft science". However it should be remembered that at the first ICIS conference, Keen (1980) argued that the relative immaturity of the discipline required borrowing from other, better established, disciplines in order to achieve academic respectability, in particular, behavioural sciences.

While certain low level information recording is part of everyday work e.g. documenting software, there are few incentives for staff to engender skills and knowledge in others. Given that one's professional worth is "measured" in knowledge and skill, enhancing those attributes in others is not in one's best interests. Not doing so is not in the organisation's best interests. Thus, there exists a state of tension between the personal and corporate needs which will result in conflict from time to time.

Many tasks undertaken in MIS require shared cognition due to their sheer size and complexity. Staff will develop an information system in a purposeful way but the social system which underpins most of the day to day operations develops in an ad hoc fashion. While Searle's (1969, 1979) theories of speech provides a basis for determining the effectiveness of communications in a group and Habermas' (1984, 1987) theory of social action are useful at a micro-level, we argue that neither is a suitable tool for anything but the smallest groups. The level of analysis and the unrealistic timescales render them useless. The effectiveness of communication and conception may be established (albeit retrospectively) by observing the behaviour of the group and its outputs. The behaviour may be influenced by changing the environment and creating new actor networks. Good project management requires frequent sampling and monitoring so the quality of outputs may be known with a fair degree of certainty. Effectively, we are advocating the use of micro-social engineering.

We hypothesise that educating managers in actor network theory should allow them to develop more effective and explicit knowledge transfer strategies. Tacit knowledge transfer occurs predominantly as a result of informal interaction and this too should be engendered. Again research is needed to confirm our view, but if substantiated then academia and industry would need to address those issues fully.

How to manage knowledge resources within organisations?

Our preliminary thinking is that the classification scheme we propose together with our IPRAM model should provide a reasonable conceptual framework for managers. Again this needs to be tested. The more well known and structured the area, the greater the scope for automation. Too much interference and control would tend to inhibit, too little would result in loss. We contend that most Know What and Know How types of knowledge activities are principally informational and may be easily automated. We argue that it is pointless to try and manage the unstructured areas even though they represent the personal-corporate knowledge nexus which is the subject of this paper. Instead we return to semiotics, social constructivism and actor network theory and suggest that attention be given to appropriate spheres of control and influence i.e. the environment in which the knowledge-based activities take place and the behavioural characteristics of the actors. As with economics we are in the realm of third order cybernetics i.e. that of complex but basically self-regulating systems. The 80 : 20 rule of human resource management applies; 80% is hiring the right people and 20% is removing obstacles from their path. Fremantle Port Authority had its MIS function managed by Jane Barton-Greig, as part of her program of reform she actively encouraged reading and social networking. Staff were told that she expected them to talk to each other and to read journals etc. during office hours and areas were set aside for these purposes. Since this was not a research project no attempt was made to measure the before and after scenarios. However Jane insists that staff were better motivated and more effective after the changes were made and that there was a higher degree of conformance vis a vis mission statements. We can offer other anecdotal arguments but in the absence of rigorous research programmes are reluctant to make firm recommendations.

Summary

We have put forward a simple knowledge classification scheme and a qualitative five-stage model to describe organisational and personal learning. These are intended to be simple and therefore accessible to MIS practitioners. In addition, we have identified two promising areas of future enquiry; meta-cognition

and thinking style education for MIS staff and the application of Actor Network Theory to the development of effective knowledge based activity management. Both of these will be subject to future, more rigorous research. We conclude that the highly unstructured nature of the personal-corporate knowledge nexus renders traditional, direct management techniques useless. Synergy of this nexus will only occur in an emergent fashion resulting from improvements in personal knowledge methods (Know Why) and corporate knowledge (low level Know How and Know What) methods. The changing nature of the MIS discipline will ensure the increasing importance of both of these Gfields to professionals and academics alike. It follows that emphasis in developing transferable skills, particularly those related to thinking, is a worthwhile investment.

References

Alvesson M. *Communications, Power and Organisation*. Berlin: Walter de Gruyter, 1996.

Banville C, Landry M. Can the field of MIS be disciplined? *Communications of the ACM* 1989;32(1):48–60

Beynon-Davies P. *Information Systems Development*. Basingstoke, London, UK: Macmillan, 1998.

Blackler F. Knowledge, knowledge work and organisations: An overview and interpretation. *Organisation Studies* 1995b:1021–1046. Cited by Johnston, R. 1988.

Callon M, Bell G. Techo-economic networks and science and technology policy. *STI Review* 1994;14:59–117.

Churchman CW. Management science: science of managing and managing of science. *Interfaces* 1994;24(4):99–110.

Coltins H. The structure of knowledge. *Social Research*, 1993;60(1):95–116.

Dahlbom B, Mathiassen L. *Struggling with Quality: The Philosophy of Developing Computer Systems*. Oxford: Blackwell, 1993.

Darlington J. The unification of functional and logic Programming. Dept. Computing, Imperial College, 1980.

Dearden J. MIS is a Mirage. *Harvard Business Review* 1972; Jan–Feb:90–99.

Dewey J. *How We Think*. Boston: Heath, 1910.

Drucker P. *Post Capitalist Society*. Oxford, UK: Butterworth, 1993.

Ernest P. *The One and the Many, Constructivism in Education*. Hillsdale, NJ: Lawrence Erlbaum, 1995, pp. 459–486.

Flavell JH. Metacognition aspects of problem solving. In: Resnick LB, ed. *The Nature of Intelligence*. Hillsdale, NJ: Lawrence Erlbaum, 1976.

Fleck J. Contingent knowledge and technology development. *Technology Analysis and Strategic Management*, 1997;9(4):387–397.

Gilb T. *Principles of Software Engineering Management*. Reading, MA: Addison Wesley, 1987.

Habermas J. *The Theory of Communicative Action: Vol. 1 Reason and The Rationalisation of Society*. Boston: Beacon Press, 1984. Cited by Weber, 1997.

Habermas J. *The Theory of Communicative Action: Vol. 2 Lifeworld and the System: A Critique of Functionalist Reason*. Boston: Beacon Press, 1987.

Harrison AF, Bramson RM. *The Art of Thinking*. New Jersey: Berkley, 1982. Cited by Kienholz A. Systems re-thinking: An inquiring systems approach to the art and practice of the learning organisation. 1999. Online: *http://www.cba.uh.edu/~parks/fis/inqre2a*

Hartwick S, Barki H. Explaining the role of user participation in information system use. *Management Science*. 1994;40(4):440–465.

Hirscheim R, Klein HK, Lytinen K. *Information Systems Development and Modelling: Conceptual and Philosophical Foundations*. Cambridge: Cambridge University Press, 1995, pp. 14–15. Cited by Weber, 1997.

Hunt R, Sanders GL. Propaedeutics of decision making: Supporting managerial learning and innovation. *Decision Support Systems* 1986;2(2):125–134.

Hutchinson SE, Sawyer SC. *Computers and Information Systems*. Chicago: Irwin, 1996.

Jones CB. *Systematic Software Development Using VDM*. Prentice Hall, Englewood Cliff, NJ, 1986.

Johnston R. The changing nature of knowledge: A review. Department of Employment, Training and Youth Affairs, 98/16, pp. 1–22, 1988.

Keen P. MIS research: Reference disciplines and a cumulative tradition. In: McLean ER, ed. *Proceedings of the First International Conference on Information Systems*. Philadelphia, PA, 1980, pp. 9–18.

Kelly GA. *The Psychology of Personal Constructs*. New York: Norton, 1955.

Keinholz A. *Systems Re-Thinking: An Inquiring Systems Approach to the Art and Practice of the Learning Organizations*. 1999. Online: *http://www.cba.uh.edu/~parhs/fis/inqreza1.htm*.

Latour B. Technology is Society Made Durable. In Law J, ed. *A Sociology of Monsters, Essays on Power, Technology and Domination*. London: Routledge, 1991, pp. 103–131.

Lyytinen K. Implications of theories of language for information systems. *Management Information Systems Quarterly* 1985;9(1):61–74.

Maturana HR. Biology of language: The epistemology of reality. In: Miller GA and Lenneberg E, eds. *Psychology and Biology of Language and Thought: Essays in Honour of Eric Linneberg*. New York: Academic Press, 1978, pp. 27–63. Cited by Weber, 1997.

Schon DA. *The Reflective Practitioner*. New York: Basic Books, 1983.

Searle J. *Speech Acts: An Essay in the Philosophy of Language*. Cambridge: Cambridge University Press, 1969.

Searle J. *Expression and Meaning: Studies in the Theory of Speech Acts*. Cambridge: Cambridge University Press, 1979.

Shannon CE, Weaver W. *The Mathematical Theory of Communication*. University of Illinois Press, 1949. Cited by Weber, 1997.

Standing C, Benson S. Beyond trust: A realist view knowledge management. Unpublished Paper, 1999.

Tomes C. You're in the money! Information Age, Aug/Sept. Australian Computer Society, 1999, pp. 11–13.

VonGlaserfeld E. Questions and answers about radical constructivism. In: Tobin, ed. *The Practice of Constructivism in Science*

Education. Hillsdale, New Jersey: Lawrence Erlbaum, 1993, pp. 23–38.
Vygotsky LS. *Thought and Language*. Cambridge, Massachusetts: MIT Press, 1989.
Weber R. *Ontological Foundations of Information Systems*. Australia: Coopers & Lybrand, 1997, pp. 54–67.

Stephen Benson is a senior lecturer in the School of Management Information Systems at Edith Cowan University in Western Australia. His research interests include the philosophical foundations of IS, knowledge management and the influence of the Internet on culture. He has presented at international conferences and has published in leading journals.

Craig Standing is a senior lecturer in the School of Management Information Systems at Edith Cowan University in Western Australia. He received his PhD from the University of Western Australia. His researchs interests include Internet commerce development, knowledge management and electronic commerce and the travel industry. He has presented at many international conferences and has published widely on IS related topics in journals.