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Architecting knowledge management for results

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Abstract: Successful knowledge management requires alignment with business objectives, integration into business processes, application by people, activities appropriate to the nature of the knowledge involved, and implementation in a pragmatic fashion. An action research approach led to the development of a model for knowledge management that enables strategy, assists in project architecture at all levels, facilitates design for return on investment, clarifies the roles of knowledge and knowledge management and contends with issues related to the tangibility of knowledge. Called the knowledge management architecture model, it may be used descriptively in mapping or prescriptively in designing entities and the relationships between knowledge and the people who use it, the processes in which it is applied and the outcomes of those processes. Results from employment of this model in two large public sector organisations and one multi-national corporation are discussed. Results show that use of the model leads to focused knowledge management projects that consequently deliver more predictable, calculable returns that business deems important.

Keywords: knowledge management architecture, process, design.

1 An introduction to architecture

Knowledge management continues to display less than optimal performance (Malhotra 2005; Arora 2002) despite adoption or investigation by most large organisations (McCampbell et al. 1999; Smalley-Bowen and Scannell 1999), and despite apparently being of enormous value to business (Tobin 2004; Davenport and Prusak 1998). If this performance is not improved, likely consequences could include reduced academic interest, dwindling research funding, organisation disenchantment and discredited practitioners. Empirical observation already suggests waning corporate interest; evidenced by a dearth of job vacancies, fewer published tenders and declining sales leads.

Whilst root causes of poor performance should be researched in depth, practical experience and literature suggest the following issues could be contributory:

- Knowledge management shows signs of not having matured beyond the 'pre-scientific' phase of scientific progress (Kuhn 1962); a state characterised by incompatible and incomplete theories, little consensus on methods and terminology, and little coherent understanding on how to take the research forward. Metaxiotis et al. (2005) agree, finding more disagreement than agreement and the field to be in its infancy.
- There is disengagement between theory and practice, demonstrated by organisations treating knowledge management quite differently to academic approaches (McAdam and Reid 2000).
- There may be excessive focus on subject rather than on problem solving (van den Berg and Popescu 2005).
- There may be too much strategy and insufficient implementation (Hsieh and Yik 2005; Smart et al. 2003; Sterling 2003).
- Focus may be overly technological (Smart et al. 2003), or on knowledge at the expense of organisation issues. Heath (2003) is of the opinion that knowledge management should be about managing knowledge processes rather than managing knowledge.
- "*The design of knowledge organisations is one of the critically unsolved issues in knowledge management.*" (Augier and Knudsen 2004)
- Research methodologies employed may be allowing overly optimistic claims (Storey and Barnett 2000) to be made without sufficient validation.
- Lessons from change management and cultural inhibitors of knowledge management (Wong and Aspinwall 2005; Yih-Tong Sun and Scott 2005) suggest the futility of theory suggesting corporate culture must change (Robb 2006).

Architecture, as an activity that occurs between business analysis and implementation (Kim et al. 2003), is in a position to translate relatively intangible strategy, objectives and intent into a more concrete and usable form. It is therefore proposed that architecture may be a solution, if its role is to

find a compromise between form, function and the needs of the various stakeholders whilst providing construction with an executable plan that will lead to a tangible result.

What is architecture? Within the information systems context 'architecture' (noun) has been regarded as a representation, defined to include the components, their configuration and relationships (IEEE Standards 2004; Bass et al. 2003).

Architecture may also be regarded as the activity of designing a system (verb 'to architect'). The consideration of human interaction and organisation, costs and decisions (Augier and Knudsen 2004) may be added to a definition of knowledge management architecture.

Knowledge management architecture is therefore defined as "*the representation of a knowledge management system including its components, configurations, relationships and environment; and the process of designing that representation with regard to its form, function, stakeholders' requirements and implementation.*"

The term 'system' is used broadly sense, referring to any configuration of people, technology, infrastructure, projects, initiatives, practices and functions.

2 Architecture model design

Definition alone is insufficient for practitioners. Empirical experience shows that a model is an efficient means of providing practitioners with a useful theory. Generic models can '*give structure to experience*' (Morris 1967) and capture the essence of real systems for manipulation and manageability (Abdullah et al. 2002). Technically, they can bring clarity to complex situations, be more communicable, generalise concepts for reuse, and transfer understanding for self-sufficiency. "*Maintaining alignment between business design and IT solutions through a model-driven architecture has the potential to greatly reduce the "time to value" of business transformations*" (Kapoor et al. 2005).

2.1 Design through action research

The knowledge management architecture model was developed in early 2003 for use in consultancy work; in response to gaps in literature, a lack of practical models to guide knowledge management systems design, and to fill a commercial demand for efficient project delivery and effective project outcomes.

Initial model design and application was undertaken during a consulting project, using a methodology that closely approximated action research. The author reviewed literature, engaged with the client's representative, and then developed the model with entities, processes and relationships deemed important by both literature and the client. As a project deliverable, the model was prepared during the first week of a much larger project. Eight iterations involving design and implementation were undertaken, each identifying key elements, generalising conceptually similar elements and reviewing the result with the client representative.

The following suggest action research was an appropriate methodology:

- Practitioners display a tendency toward framing solutions in terms of pre-inquiry understanding (Chenail and Maione 1997), yet they do have a valuable role to play as researchers (McNiff and Whitehead 2006).
- Practitioner's insider (emic) perspective (Pike 1967) is ideally placed for reflection on practical applications of theory. Consultants, as a subset of practitioners, adopt both an observer (etic) perspective by bringing externally derived theory and experience to an engagement whilst participating with an emic insight of insider understanding and aspirations.
- The ethnographic and phenomenological nature of knowledge management projects and the sociological nature of knowledge management (McAdam and Reid 2000) suggest a practical approach may be valuable in knowledge management research.
- Deductive methods are unsuited to industry research where consultants and practitioners do not have the time, unlimited resources and flexible outcomes available. Assignments tend to be

immersive, participatory and brief. Contract terms often only provide basic direction, the extent of the situation remaining unknown until well into the project.

- The use of action research by practitioners has been established. "*Action research is about practitioners creating new ideas about how to improve practice, and putting those ideas forward as their personal theories of practice*" (McNiff and Whitehead 2006, p5).
- Knowledge management consulting also displays characteristics which favour action research; including immersion, the need to produce deliverables of significance to the organisation, the need for environmental and political support (O'Leary 2005), the consulting process resembling the iterative action research cycle of *observe-reflect-act-evaluate-modify* (McNiff and Whitehead 2006), and extensive use of action research in knowledge management revealed by literature.

2.2 Developing the model

No practical model for knowledge management systems architecture was found when the original project commenced. Model design was therefore informed by empirical understanding and theories of process, knowledge and knowledge transfer. Furthermore, the model was designed to be as theory independent as possible so as to facilitate architecture regardless of each organisation's understanding of knowledge, knowledge processes and knowledge management; thereby avoiding problems associated with the wide range of approaches in the field (Metaxiotis et al 2005).

Students of design are taught, "*form follows function*", a phrase coined in 1896 by architect Louis Sullivan (1947). Applying this dictum here could resolve many of the issues described. Unfortunately literature is unhelpful in establishing what this function and form should be, with there being diverse knowledge management definitions and approaches (Patriotta 2004).

Commencing with function of a knowledge management architecture model, practitioner experience suggests that a focus on organisation outcomes is what clients are asking for. This observation is supported by document analysis of tender publications, requests for proposals, and literature such as Model 1 and 2 for knowledge management systems (Malhotra 2004). A simple, broad assumption will be made, that the role of knowledge management should be "*to enable achievement of the organisation's objectives through managing knowledge.*" Sufficient detail is provided at the operational level by a simple process model, input → process → output (Shewhart 1939).

Form of the architecture may be built around the Shewhart model. Knowledge is an obvious input. Work activity could be the process, referring to general work and not knowledge processes such as transfer or codification, a treatment suggested by knowledge value chains (Stewart 1997 p293). Several factors dictate the possible output. Resistance to measurement (Jones and Schilling 2000), resistance to change (del Val and Fuentes 2003), and organisation objectives suggest that achieving organisation goals are more suitable outputs than knowledge products. Learning may also be added to the model, to provide a control or feedback loop, shown in figure 1 below.

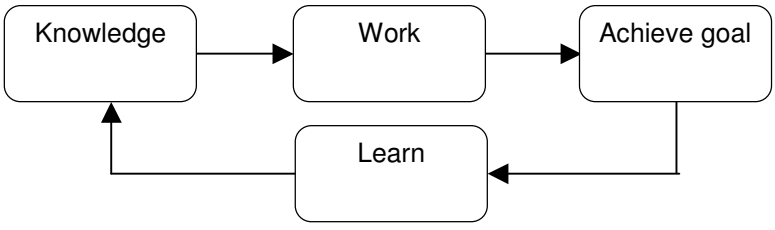

Figure 1: The core process model

Figure 1 is not incompatible with approaches such as Malhotra's "right information to the right person at the right time" (2004), Argyris' single loop learning (1992), feedback in systems thinking and organisation learning (Senge 1990), the "*know-how, know-what, know-why, care-why*" elements of knowing (Quinn et al. 1996), various knowledge mapping techniques discussed by Davenport and Prusak (1998 p72), and Darroch's (2005) conceptual model of resource based knowledge management.

Individuals and their contribution should now be mapped into the process. Components are suggested by the inseparability of people from knowledge (Baumard 1999; Polanyi 1966), the SECI knowledge transfer model (Nonaka and Takeuchi 1995), findings that employees usually internalise

knowledge before employing it (Onions 2002), relative immobility of tacit knowledge (Yakhlef 2005), and linkages between knowledge processes, work and people (Davenport and Prusak 1998 p xi). Those who know (people) are differentiated from what is known (knowledge) to allow for identification of multiple sources and users of knowledge, to allow for some organisation's definitions of knowledge that include explicit knowledge, and to separate task level activities from more general projects and processes to support finer resolution of knowledge applications.

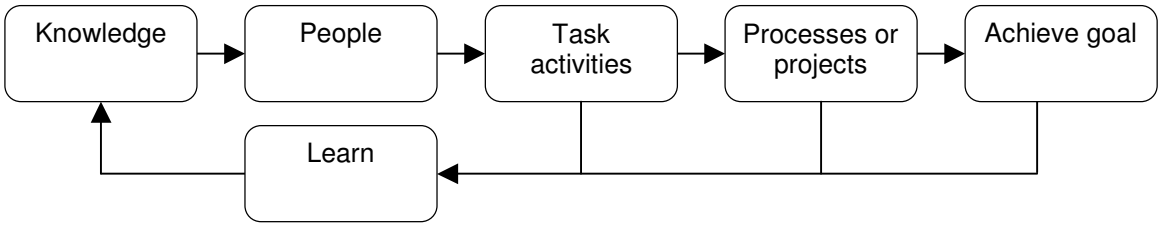

Figure 2: Model including people and process

Figure 2 reflects aspects of models such as the IS assessment tool (Myers et al. 1997) and Malhotra's models 1 and 2 (2004), and is consistent with the Zachman (1998) framework's domain views of information management.

Ex Hewlett-Packard CEO Lew Platt said, "*If Hewlett-Packard knew what Hewlett-Packard knows, we would be three times as profitable."* (Davenport and Prusak 1998), signifying the model should clarify and map types and sources of knowledge. Access to many types of knowledge through a common interface is required (Galup et al. 2003), indicating more depth and process is needed to make provision for environmental complexity and intangible knowledge. Care however should be taken not to pre-empt or prescribe selection of a codification or personalisation strategy (Hansen et al. 1999). The model should generalise the forms that knowledge may take, as shown in figure 3 below, and allow differentiation between tacit and explicit knowledge to occur at design or application level.

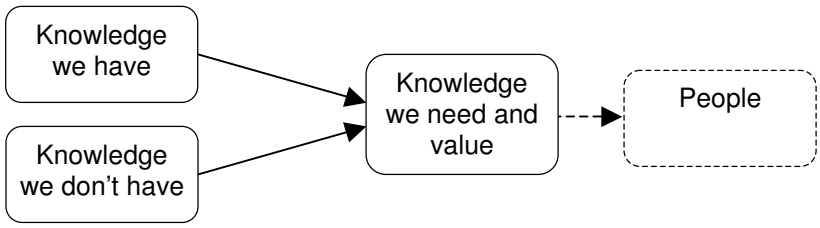

Figure 3: Known knowledge component

Examination of the use and acquisition of knowledge in organisations (Onions 2002; Baumard 1999) suggests that knowledge we don't know about or isn't disclosed may be identified during the course of work activities. Unknown knowledge may be modelled as per Figure 4 below.

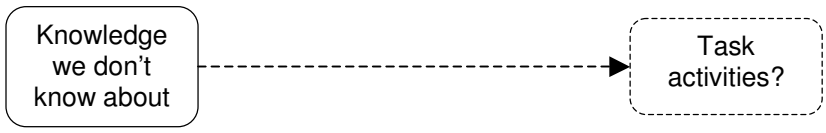

Figure 4: Unknown knowledge component

At this stage the model only represents components and configuration of the 'noun' architecture. The definition also stipulates for relationships and functions. Arrows drawn between the components represent these, consequently describing the function of architecture. Knowledge management activities would focus on the transfer of knowledge represented by the relationships (arrows), and in the processing of knowledge that will occur at each node (components). Several activities have been illustrated as ellipses in figure 5. Sources of knowledge will depend on the implementation situation. Several however have been illustrated, demonstrating the model is independent of the various forms that knowledge may take.

A 'walk-through' description of the final model in figure 5 below should demonstrate the model, as is the practice in UML modelling (Eriksson and Penker 1998):

"***Knowledge*** *that is valued and needed is located and acquired from internal and external sources by* ***people****, then used during* ***task activities*** *in the course of their work on* ***projects*** *or in* ***processes*** *to achieve* ***goals and objectives*** *of the project, team or organisation.* ***Unknown knowledge*** *may be identified during the course of activities, acquired or created, then used in the same way. People* ***learn*** *during the course of work, on reviewing progress and evaluating outcomes. Lessons and new knowledge are then fed back into the system through learning, increasing known knowledge*."

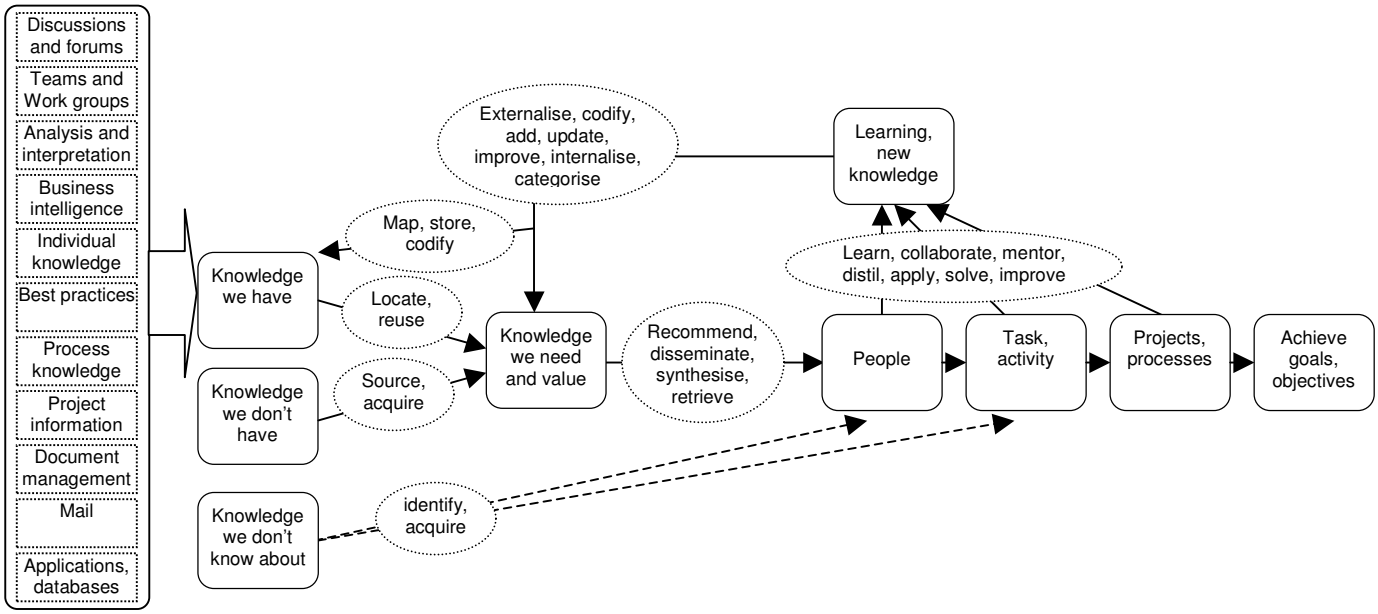

Figure 5: The knowledge management architecture model

Inspection shows this model is commensurate with Matsumoto et al.'s (2005) requirements for knowledge management that is designed to support knowledge processes; "*it is essential to identify what knowledge should be captured, why it is of value, how can it be captured, how can it be stored, how can it be retrieved, and how will it be used*."

2.3 Applying the model

Use of this model suggests there are three modes of employment:

- An illustration of the architecture process: to convince management of rigour, to describe the process and output to teams, and to plan projects.
- An analysis template: to guide elicitation of details and idiosyncrasies of each project during business analysis interviews and joint application development workshops (JAD: Wood and Silver 1995), and to deconstruct situations.
- A design template: conceptualising alternatives, identifying suitable tools and techniques at each node, and architecting the overall solution.

Use of the model suggests the sequence of events in architecting solutions using the model would typically be:

- Identify a business requirement, often by targeting poor performance areas.
- Describe the model to management to enlist their support in finding any possible solutions.
- Present the model to the team, so they may understand their role and prepare.
- Hold a JAD session. The business analyst walks the 'client' through the model, *from right to left*. Requirements and processes will be identified and analysed at each 'node' and relationship in the model. Questions are asked, such as:

    1. What organisation goals, objectives, outcomes need to be achieved?

2. What projects and processes contribute to that?
3. What work activities do people perform on those projects?
4. Who are the people?
5. What knowledge do they know they need to do that work?
6. What knowledge do they have?
7. What knowledge don't they have?

The analyst will then identify appropriate knowledge and knowledge management tools and techniques by asking questions of the JAD group, such as:

- (Between questions 4 and 5). How do we make the knowledge available to people at the right time? What does this knowledge look like?
- (Between questions 5 and 6) How do we locate and reuse that knowledge?
- (Between questions 5 and 7) How do we specify, source and acquire that knowledge? Who owns it? Where might it be stored for optimal efficiency?

The analyst will then assess potential solutions, possibly by describing alternatives to the group and soliciting feedback.

- The results of the JAD are then used to architect a solution. The analyst applies the model as a template, working *from left to right*.
- Once conceptualised, the solution is presented to management and teams for review.
- A system is then developed, pilot tested, evaluated, modified and released. Note the definition provided in the introduction for system is not exclusively technological.

3 Architecture model validation

Since its development, the knowledge management architecture model has been employed in twenty-two public sector and corporate knowledge management projects. Analysis of the 'what-happened' and 'why-did-it-happen' should lead to the 'what-can be-learnt-from-this', necessary to improve practice and the body of knowledge. One means of analysing findings, documenting application and validating theory is the case study method:

- Case studies offer authenticated evidence to demonstrate internal validity and illustrate application of theory (McNiff and Whitehead 2006 p157).
- Case study research is suited to the access and emic understanding that practitioner researchers have in order to develop the deep insights necessary (Tellis 1997).
- Review of literature shows that case studies are widely used in knowledge management to document findings and validate theory.
- Consultants are in a position to derive findings from across their portfolio, partly avoiding one criticism of the case study method that it is unable to produce generalisation due to insufficiency of cases (Yin 1993).

Three cases have been chosen from the portfolio of implementations. They have been selected on the basis of variety, clarity, availability of detailed data and the ability to contribute and publish findings.

3.1.1 Case 1: Retention of consultant knowledge

Retention of international consultants' knowledge at a government department was one of the first applications of this model. International experts were providing consultation in the privatisation of state owned assets, and their services were being reused on similar projects rather than transferring this capability to the department.

- The model was used to deconstruct and explain the problem to department management in an hour-long workshop. It was found that knowledge management was valued by everyone and supported by none. This predisposed a solution that wouldn't require management intervention.
- A three hour workshop followed, in which:
  - Organisation outcomes were identified to be 'retention of consultant knowledge' and 'reuse of consultant knowledge'.

  - Consulting processes appeared to involve production of discrete deliverables such as reports for larger projects. Tasks appeared to be analytical and advisory, and consultants were largely autonomous.
  - No formalisation or codification of the processes that converted knowledge into recommendations was found.
  - Consultants appeared to use years of expertise and best practices in formulating solutions, with much knowledge being tacit.
  - Alternatives for each 'node' and 'relationship' were proposed and assessed

- A workable, technical design was prepared on the basis of this information over a two-day period. The solution called for all external consultants to codify their methodology whilst producing deliverables, and to involve a designated staff member in their activities. Documents would be stored in the repository, and involved staff members were to disseminate knowledge through preparing reports, holding workshops and being included in similar future projects.

Research findings include:

- The model enabled clear situation deconstruction and analysis of potential alternatives
- Problem-centric design of the solution was possible, and the tangibility of the outcomes was improved.
- Delivery was efficient.
- Assigning clear roles and responsibilities at the operational level was facilitated.
- Use of the model helped transfer understanding of the analysis and design processes from the consultant to the client.
- An analyst still has to possess a broad knowledge of knowledge management tools, techniques and knowledge transfer mechanisms to be able to elicit correct information and propose suitable alternatives at each node.

3.1.2 Case 2: Knowledge mapping

The second case is that of a government directorate that required a human resource audit process and skills taxonomy. It was proposed instead to use the model to design a knowledge map linking tacit and explicit knowledge to people, projects and outcomes.

- A database was initially populated with roles, processes and projects. This required unexpectedly extensive administration to analyse and record.
- Roles and processes were then mapped to a list of individuals imported from the email system.
- A pilot group listed their skills and sources of information.
- These were 'mapped' using a hyperlink to the relevant document or email address of the 'knower'.
- Human resources began grouping and defining skills.
- Roles were identified, and mapped to skills required
- Gaps could then be identified.
- The resulting database could be used to identify career development requirements for individuals, training programmes to remedy organisation deficiencies, duplicated 'pockets' of knowledge to consolidate, organisation experts and to build a 'yellow pages' directory of experts.

Research findings for this case include:

- The model could efficiently map people to processes, outcomes and knowledge.
- A knowledge expert was required to build a consistent model of the organisations knowledge.
- Organisation experts were vital for specification of generic roles.
- Depending on organisation culture, management intentions should be clearly communicated to those involved and potential change management issues addressed.
- It was more efficient to elicit all information in one sitting from each individual. This tended however to generate concerns about job security and micro-management of their activities.

The outcome was that considerable resistance from individuals realising the extent of information to be gathered stalled the project, and the project was eventually restored to its original remit.

3.1.3 Case 3: Consolidation of dispersed knowledge

A large multi-national corporation wished to apply knowledge management to a performance management initiative. The initiative assisted managers with setting and achieving targets and motivating the workforce, and consisted of a central administrative group, distributed centres and roaming organisation consultants.

- The model was used to educate management on the concept of knowledge management.
- A JAD workshop was then convened; attended by the consultant, knowledge manager and five of the team's representatives as domain experts.
- Objectives for knowledge management were identified as providing the organisation with access to the initiative's knowledge, to facilitate communication, and to facilitate consolidation.
- Issues were identified to be time, access to technology and internal capabilities.
- Existing work processes were examined, suggesting common practices that could be automated or 'quick wins' that could easily be implemented.
- Knowledge appeared to be dispersed, inconsistent and poorly managed. Knowledge was being generated widely, but not stored and more importantly no one knew who had it. Lessons learnt were being transferred orally and without any methodology. Knowledge was often in an unusable or impractical format. One example was documents stored in a common drive that workers who were computer illiterate could never access.
- Functional knowledge areas were identified, and the role of 'knowledge coordinator' for each area assigned to a client representative.
- Each representative was provided with a template worksheet that allowed them to find and record details that were necessary to populate the model, such as for the 'knowledge we need' node:
  - Name and describe the knowledge?
  - What is its source (name the person, job, group, document, repository etc)?
  - What format is it in (document, spreadsheet, skill etc)?
  - How might this knowledge be acquired, stored or referred?
- This information was then used to design a web site that enabled its customer's needs for tacit and explicit knowledge, and allow the team to consolidate its knowledge in a consistent and intuitive way.

Findings included:

- Management could budget the project accurately, on the basis of obvious outcomes and specific designs.
- Email evidence shows the model's clarity and systematic approach helped take manager's knowledge beyond that which they had gained from editorials and management textbook chapters, understand the issues involved, formulate strategy and justify expenditure.
- Model efficiency was demonstrated, planning and analysis taking only one day.
- Tacit knowledge and socialisation processes (Nonaka and Takeuchi 1995) that characterized this organisation function were not ignored or codified. The model helped the team design a solution that allowed tacit and explicit to coexist and service the same people and processes.
- Skills in knowledge architecture were transferred from the consultant to the client.

4 Conclusions

Extended and diverse use has shown the model to be an important tool in one knowledge management consultant's toolbox, ensuring greater consistency, efficiency, precision and maturity.

The model benefits clients in several ways. Solutions can be designed for specific organisation objectives, display quantifiable, predictable value and consequently support feasibility study and budgeting. Management intuitively recognise the model's configuration, communication of ideas is supported, generalisation of most situations with no modification is possible, and analysis of complex situations is clearer. Teams have a clear, obvious process to adhere to and be measured against.

The model benefits projects by ensuring a systematic, consistent approach, focusing on solutions development and organisation outcomes that have been lacking in knowledge management. Diverse tools and techniques may easily be integrated. Right to left application ensures that form follows

function and knowledge management is subordinate to organisation objective. Left to right technical design ensures that knowledge management is efficient.

The model does have limitations. Case studies presented show good understanding of knowledge and knowledge management are necessary; and culture, organisation structure and change management must be borne in mind.

5 References

Abdullah, M.S., Benest, I., Evans, A. And Kimble, C., "Knowledge Modelling Techniques For Developing Knowledge Management Systems", 3rd European Conference on Knowledge Management, Dublin, Ireland, September 2002, pp15-25

Argyris, C. (1992) *On Organisational Learning*, Blackwell, Oxford

Arora, R. (2002) "Implementing KM – a balanced score card approach", *Journal of Knowledge Management*, Vol 6 No.3, pp 240-249

Augier, M. and Knudsen, T. (2004) "The architecture and design of the knowledge organisation", *Journal of Knowledge Management*, Vol 8 No.4, pp 6-20

Bass, L., Clements, P. and Kazman, R. (2003) *Software Architecture in Practice*, Second Edition, Addison-Wesley, Boston

Baumard, P. (1999) *Tacit Knowledge in Organisations*, Sage, London

Chenail, R.J. and Maione, P. (1997) "Sensemaking in Clinical Qualitative Research ", *The Qualitative Report*, Vol 3, No.1, March

Darroch, J. (2005) "Knowledge management, innovation and firm performance", *Journal of Knowledge Management*, Vol. 9, No.3, pp. 101-115

Davenport, T.H. and Prusak, L. (1998) *Working Knowledge*, Harvard Business School Press, Boston

del Val, M.P. and Fuentes, C.M. (2003) "Resistance to change: a literature review and empirical study", *Management Decision*, Vol 41 No.2, pp 148-155

Eriksson, H. and Penker, M. (1998) *UML Toolkit*, Wiley, London

Galup, S.D., Dattero, R. and Hicks, R.C. (2003) "The enterprise knowledge dictionary", *Knowledge Management Research & Practice*, Vol 1, pp 95-101

Hansen, M.T., Nohria, N. and Tierney, T. (1999) "What's your strategy for managing knowledge?" *Harvard Business Review*, Vol 77 No.2, pp 108-116

Heath, J. (2003), "Harvesting and using corporate knowledge", *Work Study*, Vol. 52, No 4, pp. 184-189

Hsieh, T. and Yik, S. (2005) "Leadership as the starting point of strategy", *McKinsey Quarterly*, No.1.

IEEE Standards (2004) "IEEE Standard 1471-2000 IEEE Recommended Practice for Architectural Description of Software-Intensive Systems ", [online] standards.ieee.org

Jones, S.D. and Schilling, D.J. (2000) *Measuring Team Performance*, Jossey-Bass, San Francisco

Kapoor, S., Bhattacharya, K., Buckley, S., Chowdhary, P., Ettl, M., Katircioglu, K., Mauch, E. and L. Phillips (2005) "A technical framework for sense-and-respond business management", *IBM Systems Journal*, Business Innovation, Vol. 44 No.1

Kim, Y-G., Yue, S-H. and Lee, J.H. (2003) "Knowledge strategy planning: methodology and case", *Expert Systems with Applications*, Vol 24, Issue 3, April, pp 295-307

Kuhn, T. (1962) *The Structure of Scientific Revolutions*, University of Chicago Press, Chicago

Malhotra, Y. (2004) "Why Knowledge Management Systems Fail? Enablers and Constraints of Knowledge Management in Human Enterprises", In Koenig, M. and Srikantaiah, T. (ed.), *Knowledge Management Lessons Learned: What Works and What Doesn't*, Information Today Inc., pp 87-112

Malhotra, Y. (2005) "Integrating knowledge management technologies in organisational business processes", *Journal of Knowledge Management*, Vol. 9 No.1, pp 7-28

Matsumoto, I.T., Stapleton, J., Glass J. and Thorpe, T. (2005) "A knowledge-capture report for multidisciplinary design environments", Journal of Knowledge Management, Vol. 9 No. 3, pp 83-92

McAdam, R. and Reid, R. (2000) "A comparison of public and private sector perceptions and use of knowledge management", *Journal of European Industrial Training*, Vol 24 No.6, pp317-329

McCampbell, A.S., Clare, L.M. and Gitters, S.H. (1999) "Knowledge management: the new challenge for the 21st century", *Journal of Knowledge Management*, Vol 3 No.3, pp 172-179

McNiff, J. and Whitehead, J. (2006) *All you need to know about Action Research*, Sage, London

Metaxiotis, K., Ergazakis, K. and Psarras, J. (2005), "Exploring the world of knowledge management: agreements and disagreements in the academic/practitioner community", *Journal of Knowledge Management*, Vol. 9, No. 2, pp. 6-18

Morris, W.T. (1967) "On the Art of Modeling," *Management Science*, Vol 13 No.12, August

Myers, B., Kappelman, L., and Prybutok, V., (1997) "A Comprehensive Model for Assessing the Quality and Productivity of the Information Systems Function: Toward a Theory for Information Systems Assessment," in Garrity, E., and Sanders, L., Editors (1997), *Information System Success Measurement*, Idea Group, Harrisburg, pp94-121

Nonaka, I. and Takeuchi, H. (1995) *The Knowledge Creating Company*, Oxford University Press, New York

O'Leary, Z. (2005) *Researching Real-World Problems*, Sage, London

Onions, P.E.W. (2002) *Knowledge, efficiency and effectiveness*, MBA dissertation, Oxford Brookes University

Onions, P.E.W. (2004) "Knowledge management in practice", Guest lecture to BSc (Hons) students at *University of Pretoria*, 26th February

Patriotta, G. (2004) "On studying organizational knowledge", *Knowledge Management Research & Practice*, Vol 2, pp 3-12

Pike, K.L. (1967) *Language in relation to a unified theory of structure of human behavior*, Mouton, The Hague

Polanyi, M. (1966) *The Tacit Dimension*, DoubleDay, New York

Quinn, J.B., Anderson, P. and Finklestein, S. (1996) "Managing Professional Intellect: Making the Most of the Best", *Harvard Business Review*, Vol 74 No.2, pp 181-193

Robb, D. (2006) "Why today's corporate cultures must change", *Handbook of Business Strategy, pp 249-25.*

Senge, P. (1990) *The Fifth Discipline: The Art and Practice of the Learning Organization*, Currency Doubleday, New York

Shewhart, W.A. (1939) *Statistical Method from the Viewpoint of Quality Control*, Dover Publications, NY

Smalley-Bowen, T. and Scannell, E. (1999) "Making knowledge mean business", *Info World*, Vol 21 No.8, pp 69-70

Smart, P.A., Maull, R.S., Radnor, Z.J. and Housel, T.J. (2003) "An approach for identifying value in business processes", *Journal of Knowledge Management*, Vol 7 No.4, pp49-61

Sterling, J. (2003) "Translating strategy into effective implementation: dispelling the myths and highlighting what works", *Strategy and Leadership*, Vol 31, No.3, pp 27-34

Stewart, T.A. (1997) *Intellectual Capital: The New Wealth of Organisations*, Doubleday, New York

Storey, J. and Barnett, E. (2000) "Knowledge management initiatives", *Journal of Knowledge Management*, Vol 4 No.2, pp 145-156

Sullivan L. (1947) "The Tall Office Building Artistically Considered." In: Athey I., ed. Kindergarten *Chats (revised 1918) and Other Writings*, New York, pp202-13

Tellis, W. (1997) "Introduction to Case Study", *The Qualitative Report*, Vol 3, No.2, July [online] http://www.nova.edu/ssss/QR/QR3-2/tellis1.html

Tobin, T. (2004) "The Top 5 Reasons You Need KM – Today", In "Best Practices in Enterprise Knowledge Management", *KM World white papers*, November-December, [online] www.kmworld.com

van den Berg, C. and Popescu, I. (2005) "An experience in knowledge mapping", *Journal of Knowledge Management*, Vol 9 No.2, pp 123-128

Wong, K.Y. and Aspinwall, E. (2005) "An empirical study of the important factors for knowledge-management adoption in the SME sector", *Journal of Knowledge Management*, Vol 9 No.3, pp 64-82

Wood, J. and Silver, D. (1995) *Joint Application Development*, Wiley, New York

Yakhlef, A. (2005) Immobility of tacit knowledge and the displacement of the locus of innovation, *European Journal of Innovation Management*, Vol 8 No.2, pp 227-239

Yih-Tong Sun, P. and Scott, J.L. (2005) “An investigation of barriers to knowledge transfer”, *Journal of Knowledge Management*, Vol 9 No.2, pp 75-90

Yin, R. (1993) *Applications of case study research*, Sage Publishing, Beverly Hills, CA

Zachman, J.A. (1998) “The Framework for Enterprise Architecture (The “Zachman Framework”) and the Search for the Owner's View of Business Rules”, *Database Newsletter*, Vol 1 No.26