KNOWLEDGE IDENTIFICATION WITHIN THE INFORMATION INFRASTRUCTURE OF A LARGE MULTIDISCIPLINARY CONSULTANT

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Knowledge Management (KM) practitioners and technology suppliers are eager to promote the value of advanced tools and techniques for identifying and extracting knowledge from digital data. Difficulties exist in applying these KM methods to organisations and this is particularly true where there exists complexity in the information technology (IT) infrastructure, geographic dispersion as well as technical diversification. The IT infrastructure of a large multidisciplinary consultant coupled with particular characteristics in the information-seeking behaviour of engineers and managers need to be fully understood, and potentially changed, before attempting to implement knowledge management improvements.

Keywords: Knowledge management, Civil Engineering, Organizational culture, Information Technology Infrastructure.

INTRODUCTION

There is significant belief that adopting Knowledge Management (KM) technologies for the extraction of knowledge from digital data will prove beneficial to businesses (Mach et al 1999). Knowledge can be represented in a number of ways with tacit and explicit aspects but a basic taxonomy would include:

- Know-what; codified information and data such as statistics, technical information, designs
- Know-how; skills and abilities embodied in people
- Know-why; the deeper theoretical understanding of business

The technologies available to support KM also take on many forms but primarily focus on:

- Capturing and Codifying Knowledge
- Creating Knowledge
- Sharing and Leveraging Acquired Knowledge

Such technologies include web-collaboration tools, Intranets, reference libraries, search engines and data mining tools.

Numerous arguments exist encouraging built environment organisations to adopt KM practice to sustain and improve corporate skills and capabilities. These include:

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- Decreasing applications to built environment University courses. It has been suggested that at the present decline rate, civil engineering applicants will be 0 by 2009 (Fairclough 2002)
- Increasing attraction of other disciplines such as IT or commerce (Simmonds and Clark 1999)
- Increasing globalisation demands higher value services for Western companies to compete with emerging nations (Figel 2004)

However, despite the belief that KM is beneficial to built environment organisations, most supporting cases site discrete examples, whilst cross-organisational KM success stories prove difficult to identify (Malhotra 2002). Some of the key reasons are likely to relate to the complexity of existing organisational technologies and the cultural aspects of staff being in conflict with the expectation of a KM solution.

ENTERPRISE TECHNOLOGIES

Enterprise technologies affect the degree to which KM tools can be applied. If an organisation's information technology architecture or information management policies conflict with KM then the level to which KM can be adopted may be significantly restricted.

A typical large engineering organisation would have single or multiple instances of:

- A finance system
- Human Resources application
- CAD Management tools
- Intranet
- Collaborative working systems
- CRM
- Timesheet
- Business Quality Management System

Two key difficulties that emerge when applying a KM system across the various enterprise technologies are the degree of integration possible and the consistency of the 'knowledge' available. For example, a search engine posing as a KM service might return variable results when querying enterprise applications due to access restrictions and format of stored data.

Since few if any KM technologies can address the integration and knowledge quality difficulties, the result is that KM implementations tend to focus on only certain enterprise technologies or as standalone services. A number of organisations have chosen to implement 'communities of practice' that share technical knowledge amongst target interest groups. For example Flour in the United States developed Knowledge OnLine and managed to operate 36 knowledge communities amongst its 14,000 employees (Carrillo 2004).

Current KM solutions are also unlikely to address the changing IT environment where enterprise architectures are evolving to exploit improvements in technology, focus on user requirements, improve integration, and to move away from standalone systems. Current trends include:

- Service Oriented Architecture (SOA) where software is presented as discrete components or services rather than a large single application
- Model Driven Architecture (MDA) that exploits an interpretation layer between the logic of the software and the various technical functions it performs
- Event Driven Architecture (EDA) where distributed systems can notify applications when events of special interest occur.

SOA can implement a KM tool as a discrete service to be exploited by users. However, the KM service must still be able to access the data and potentially interpret how other services use data to generate useable knowledge.

MDA is a work in progress (Brown 2004); with the very definition of MDA evolving. In a narrow sense it is about different abstract models of a system, and well-defined model transformations among them. In the future KM could benefit from the adoption of MDA because the logic of how systems manipulate data will be captured using standard techniques allowing a knowledge technology to provide more informed results to queries.

EDA has the potential to provide a solution to delivering highly focused KM to businesses. However, it is an immature technology that is not expected to be exploited by systems planning until 2007 or 2008 and potentially not widely deployed for a further 20 years (Effective IT Report 2005).

Emerging technology

A further technology change that will heavily influence the future of KM is the development of the semantic web. The Semantic Web is presently a vision of an extension of the current Web in which information is given well-defined meaning, enabling computers and people to work in better cooperation. The W3C Semantic Web Activity (Berners-Lee and Miller 2002), in collaboration with a large number of researchers and industrial partners, is presently tasked with defining standards and technologies that allow data on the Web to be defined and linked in a way that it can be used for more effective discovery, automation, integration, and reuse across applications. The vision is that the Web will reach its full potential when it becomes an environment where data can be shared and processed by automated tools as well as by people; essentially a KM environment that can be interrogated and understood by both machines and humans.

BEHAVIOURAL ASPECTS

It is not always appropriate to adopt KM purely on the basis of the potential of a given technology, without appreciating the nature of the target audience. Engineers and other Built Environment Professionals are commonly educated to identify solutions from first principles. Such a philosophy is in conflict with KM which encourages ‘searching’ or consulting expert sources. Taking such an approach might be seen as a sign of weakness in the individual as they should be able to achieve a result with minimal input form others.

A study of a cross section of Engineering and Construction Firms in the United States (Veshosky 1998) identified that employees did in fact have a fairly active information-seeking behaviour regarding innovations that might represent solutions to their problems. However, they obtained their knowledge almost exclusively from

conversations with colleagues and advertising-supported trade press. Electronic information sources were also increasingly being used as a source of knowledge both from internal networks and the Intranet. None of the interviewees cited using conference proceedings, professional journals or academic courses for keeping up-to-date or helping to solve problems.

It could therefore be inferred that built-environment professionals are reluctant to rely on 'refereed' information sources but happy to take on anecdotal evidence. From a KM perspective this raises challenging questions:

- Does the target audience want verified expert knowledge?
- Are 'trade' sources of greatest value?
- Will detail ever be required?
- Should an intensive re-education programme be developed?

The current trend to adopt internally focused solutions to KM such as Communities of Practice can also be seen as a continuation of the common information sharing efforts identified by Veshosky where the most used techniques were:

- Conducting internal technical seminars
- Producing internal technical reports
- Maintaining files or databases of innovation information
- Encouraging project managers and engineers to participate in professional activities
- Encouraging project managers and engineers to interact with vendors

From a KM perspective these processes only offer localised benefits with short term value. Additionally, with the exception of maintaining databases of innovation information, the benefits of the information sharing activity are for the individual rather than the organisation.

KNOWLEDGE MANAGEMENT TRIALS

The described difficulties relating to the introduction of KM technology have not prevented organisations investigating the potential of KM. The UK's largest multi-disciplinary engineering consultancy Atkins recognises the potential value of KM and has been involved in a number of collaborative research projects as well as invested in internal research into the topic. Projects have included:

- C-Sand
- Organisational Memory and Innovation in Project-Based Firms
- Strategic Intranets: meeting business goals with technology
- ARKMAP: Atkins Rail Knowledge Management Pilot

C-Sand

Atkins was a partner on the EPSRC funded CSand *(Creating, Sustaining, And Disseminating Knowledge For Sustainable Construction: Tools, Methods And Architectures)* project from July 2001 until November 2004 (Khalfan et al 2003). Atkins main role was to contribute to the concept validation and requirements capture

work that was essential to the project. This involved providing a range of case studies to the research team.

The research team (Loughborough University, the London School of Economics, and Salford University) developed a promising KM platform that facilitated the acquisition and management of knowledge to support sustainability practices. This was based on a Web Services Model, and comprised a wide range of services that tried to integrate information and knowledge handled by legacy and commercial IT systems, while providing advanced search functionality based on a user profiler service.

The field trial and evaluation work of the CSand platform recognised that the portal had real potential in becoming a major resource for knowledge management. However simple lessons emerged relating to the usability of the portal that would define the success or failure of extended development and included:

- Even a research system needs a Help menu
- System (concept?) complexity meant that users ended up ‘double searching’ i.e. they found the best method of operation was to find something on Google and then refining that result using C-Sand to 'drain' the identified website of its useful information.
- Long knowledge folder list can be cumbersome to use if very long
- The terminology is not what people are used to
- There are many functions that people take for granted in their software, for example 'undo' and 'back/forward' that were missed.
- People came to the conclusion that the power in C-Sand is in the management and sharing of knowledge, not necessarily the identification of knowledge.

Organisational Memory and Innovation in Project-Based Firms
Atkins sponsored a DPhil at the University of Sussex Science and Policy Research Unit (SPRU) entitled Total Recall? Organisation Memory and Innovation in Project-Based Firms (Cacciatori 2003) from 1999 to 2003. The doctorate examined how processes through which engineering design consultancies integrate knowledge across projects and professions. The research sought to answer two questions:

- How competencies are accumulated at the level of the firm despite the discontinuity of project operations
- How firms can manage the integration of bodies of knowledge that have traditionally been the exclusive domain of specialised professions and occupations

Among many findings the research revealed that firms are a long way from having found a satisfactory way to achieve the integration of knowledge necessary to obtain expected gains in new procurement models such as PFI. There is a distinct lack of appropriate data to estimate whole-life costs as it is captured in in-appropriate forms e.g. management accounting terms, or is too disorganised to be of use.

The research also underlined the common observation that people do not want to share knowledge because ‘knowledge is power’. It became clear that knowledge accumulation and conflict go hand in hand, but that, through the use of specific tools and processes, managerial intervention could assist. The processes, where however

found to be emergent rather than proven, making it impossible to define appropriate KM methods to deal with conflict. Moreover IT tools proved ineffective in compensating for difficulties encountered by social networks in managing the problem of competencies and their location. The required sophistication of IT tools was believed to be a much higher investment than a rationalistic, computer-based understanding of social networks might predict. Essentially the research revealed that technology would be unable to improve knowledge sharing, without extensive effort to modify behaviour.

Strategic Intranets: meeting business goals with technology
In early 2005, Atkins supported a team of post graduate students from SPRU on a project looking into how alternate enterprise architectures, supported by search technologies, could augment ongoing enhancements to the Atkins Intranet. The study of Atkins Intranet focused on:

- The information and service requirements for project delivery
- The strategy, applications and technology of the Intranet that support delivery of project outputs
- Benchmarking against intranets of other project-based organisations in a range of sectors

A particular challenge in the study was to examine the degree to which an effectively designed and managed intranet could deliver knowledge management, in order to allow an organisation to:

- Develop and profit from unique knowledge assets
- Support the needs of staff in their roles as knowledge workers

The study revealed that Atkins Intranet was ahead of many studied, but could no longer be seen as at the forefront of Intranet practice (Zazzerinf et al 2005). The Intranet was seen to be a useful administrative tool but was not used a significant source of information for the delivery of project outputs. Intranet use was also undermined by difficulties in the identification of content due to structure, navigation and searching.

The inference from the study was that shared corporate information was not used in the technical delivery of projects. This could have been caused by no desire from the audience to employ it or that technological issues with structure and identification meant that users were unable to employ it for project delivery.

From the other benchmarked Intranets only two organisations believed that their Intranet helped support project delivery. Both companies had introduced a sophisticated search engine to support their Intranet and both companies used communities of practice to share knowledge. However, the focus of the knowledge sharing was not on project delivery as much as on winning projects. It could therefore be argued that innovations on past projects and the expertise of the project participants would be used for future bidding purposes but not necessarily employed on won projects.

ARKMAP: Atkins Rail Knowledge Management Pilot
An initiative was begun within Atkins rail division to explore the benefits or KM to the business in 2001 through the creation of a ‘Blue Sky Club’ of internal and external

experts. This led to a case for a KM system being proposed in 2002 with a pilot project budget approved in early 2004. The case for KM (Hessami 2004) focused on:

- Capitalising on Corporate Knowledge
- Empowering Experts
- Sharing Best Practice
- Addressing the Age Profile in certain rail business units
- Supporting Overseas Expansion

The pilot was commenced in mid 2004 using the Open Text Corporation software LiveLink. The software was selected on the basis that it provided the anticipated user and data management functionality and because a service could be rented for the 9-month pilot period.

The pilot site was configured with the intention to provide a single repository capturing past and future information which currently lies disorganised in the hands of a few and to make it available in an organised productive manner to others. The configuration focused on 'feeding' information relating to drivers and inhibitors to the various identified knowledge domains.

The pilot ended in early 2005. It succeeded in having four operating sites for different business units, it tested and verified the required functionality, utilisation metrics to evaluate system adoption were developed, and a wider business case for KM was generated.

The pilot did however ultimately suffer from relatively low utilisation and identified that many target users struggled to understand the conceptual basis behind the study and consequently the requirement for them to actively participate. Although a wider business case was developed it has not yet received approval as the underlying problem is that the benefit and application within the wider organisation has proven difficult to verify.

CONCLUSIONS

KM focus does not appear to have changed with the introduction of technology. Where previously built-environment organisations carried out internal seminars or publications and expected staff to keep abreast of the industry publications, today organisational KM practitioners create internal communities of practice to exchange experience.

Attempts to introduce more sophisticated models of KM have tended to be little used, in line with identified characteristics of industry professionals who tend not to seek 'academic' enlightenment but prefer anecdotal or trade information. Where organisations are employing KM its applications focus on winning work rather than in building on past innovations or raising the collective skill levels in the organisation.

KM is itself evolving and heavily influenced by technology changes. Search engines and information management tools dominate the current market but tend to operate in isolation. As new software architectures are adopted, KM may form a core of the enterprise rather than a bolt-on tool. The current poor integration of KM technologies with enterprise systems is diluting the potential impact within organisations.

Atkins efforts demonstrate that appreciation of organisational and behavioural issues is no less important than evaluation of technologies and their potential benefits. Essentially, the value of an enterprise KM technology should be thoroughly identified before introduction to an organisation and once selected the organisation must be prepared to change how its employees behave to exploit the potential.

It is possible that the scale of required change can only be driven from outside the enterprise; perhaps the evolution of the semantic web or changes in undergraduate education? Organisations within the built-environment sector will need to take action if external forces influence how knowledge is generated and shared because, for operational success, the quality of the adopted information must be verified and validated before being applied.

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