2. ISSUES IN KNOWLEDGE TRANSFER

Within an organisational context 'training' is distinct from 'learning' in that the former focuses on the 'delivery' model whereas learning focuses on determining the 'effectiveness' of that delivery. To distinguish between 'training' and 'knowledge transfer' one could employ the alias term 'micro-training' to describe the latter. 'Micro-training' defines the precise targeting by role within a specific domain of focused, specialised training in real-time causing the minimum disruption to the organisation. Training is distinct from learning in that the former focuses on the delivery model whereas learning focuses on determining the effectiveness of that delivery.

In a stable, 'box-selling' market blanket (macro) training is the 'norm'. With the trend towards the 'solutions' marketplace in which the vendors are asked to contribute to customers solutions holistically – other skills delivery become the 'norm' including the ability to 'understand' and transform current knowledge into a solution. Better communication is one necessity but the ability to 'share' information experience is necessary also. This requires a model which can focus, and the technology to deliver that model. In essence, the first model is explicit delivery of information while the second model is an implicit delivery of information in which the user must perform some induction to transpose information in one domain to its use as a solution in another domain.

To provide an example of explicit as opposed to implicit delivery, explicit training in 3 skills could be considered. An added requirement is to train in a further two skills. Such situations are common place in construction organisations where individuals may be required to carry out different tasks related to different construction projects. This could be delivered in an additional two explicit courses, or the additional knowledge (and skills) could be gained from the original three units by suitable cross-referencing and recognition by induction of common overlap between the five knowledge domains. This is implicit delivery. Such implicit delivery will only be successful if there is extensive breadth and depth in the original three units. And that the technology makes it possible to navigate, and to cross-reference the existing material so that new perspectives can be easily gained. The benefit of such implicit delivery is that the information is 'transposed' to provide useful solutions in new domains for which the original authors never conceived the original material. Ignoring the implication for copyright – this becomes knowledge transfer when supported on a global scale. There are many downsides (challenging issues) to implicit delivery of information, not least of which is that a 'model' of micro-training is required in order to provide the technology support, which is absolutely necessary to pursue such implicit delivery.

Knowledge transfer within domains such as the 'document solutions' industry will become increasingly important. Essentially 'transfer' involves the sharing of 'best-practice' between the minority of experienced experts and the majority of those people as recipients. Some means of capturing this information and then applying this to a problem context defines the 'knowledge' component. There are consequently four pragmatic issues to the delivery of a viable knowledge transfer system:

a) the collection of information
b) the structuring of information
c) the transfer of information
d) the auditing and measurement of effectiveness of delivery and assimilation

These are not orthogonal in the sense that collection of information will be significantly hindered if standards and protocols are not established in advance to ensure its common structuring and to maintain portability and sharing within a common information repository. When dealing with the structuring of information and its retrieval, there is a need to consider the issue of indexing:

a) the extraction of indexes from the semantics of information content
b) the merging of global centralised shared indexing and peripheral localised non-shared indexing
c) layering and levelling of information

The XML language provides a protocol for the interchange and sharing of document structure as well as content, but does not address how such structures can be merged or separated. XML may be stored in a relational database as free text. However this deprives the user of the capability of searching the relational schema based on the semantics of structure unless the XML is exported to another tool. Ideally, one would wish to capture the semantics of XML within the relational schema as meta-data such that the semantics of the structure stored within the relational schema may be queried. This would allow the querying (and comparison) of the semantics of structure. There are customised relational schemas which can also store the structure of documents but which do not offer this global standardisation.

This may indicate the limitations of XML in promoting a hierarchical structure for document element structuring, but will undoubtedly be remedied in the near future with developments such as Topic Maps which enable networks of links to be structurally represented. Having the capability to represent the structure of documents in XML and to store this in a relational database repository does not, however, address any of the other issues.

The use of log files to extract navigational trails is an interesting possibility in order to identify potential index structures. Unfortunately, the quantity of such information is a problem. Some means of summarisation may be possible such as identifying a web page (node) by a single theme or concept; this cluster being supported by a number of keyterms. Statistical packages may then be applied to identify major patterns such as seasonal variation, cyclical trends, with the application of neural algorithms to identify less obvious patterns in the residuals. This would be performed on the concept and its keyterms, essentially a text fragment which significantly reduces the information content.

There are neural network packages such as that of neurodynamics which can perform concept comparison which would be ideal for the automation of such an indexing task. However, in order to build a knowledge structure these concepts need to be ‘connected’ to other similar concepts within some frame representation, such that low level concepts provide a certain level of detail (the hierarchical level) but can be abstracted themselves into a higher layer concept (the network connectivity). Such knowledge structures can then be continually extended and navigated during the process of ‘knowledge transfer’ (See Figure 1). The frame infrastructure is just a means of providing a consistent infrastructure to represent the concepts and is not used to provide a traditional production rule based decision mechanism. The hierarchy to some extent shares similar properties to those of earlier ‘blackboard’ systems, but ‘organically grows’ by acquiring new information. Concepts themselves may behave as keyterms for other concepts higher in the hierarchy, but only paired associated concepts may be ‘connected’. Such n-ary or network associations between concepts represents a ‘context’ or solution scenario. The indexing detail is provided by the hierarchy structure, whilst the connectivity is provided by the ‘network’ structuring. Knowledge is the application of

information. In this mechanism, the connection between different ‘contexts’ (clusters of web nodes) provides the application of this ‘indexed’ information.

In this mechanism, comparison of two indexes would effectively mean the translation of the XML document structure to a frame structure of concepts and its key terms. Further connectivity between such ‘concept’ (theme) nodes to aggregate higher layer semantic indexes within the database would then be possible. This aggregate structure could then be read as a text fragment with its own grammar by a suitable neural package and likewise compared to a different text fragment. The ‘merged’ grammar would represent the new indexing structure which can then be reconstituted into a frame representation within a relational database.

Such a mechanism also provides a solution to the automation of merging local to global indexing structures. The resultant ‘merged’ index should still be validated by an indexer to ensure correctness, but even tolerant of errors, this ‘approximation’ should enable information to be more quickly and usefully shared. Of course, this ‘resultant’ index which is accrued represents a global corporate consensus and may not be an ‘ideal’ index. Hence then the need to validate by a trained team of domain knowledgeable and skilled ‘indexers’ – a specific but often neglected organisational role within a company.

Story templates could be provided within a knowledge portal to help contributors and readers alike to provide interesting and relevant information. This would be gathered, organised and ultimately supported by a centrally organised index. Both the unstructured and structured (index) aspects of information constitute – the corporate memory necessary for knowledge transfer (Hackbarth and Grover, 1999).

A company may also maintain a fixed central index and permits individuals to create isolated structures of their own volition without the ability to share and interact with this gained information. This would not be an effective learning organisation, but may be typical of countless construction companies undergoing the transition to the ‘learning organisation’ who believe in ‘knowledge transfer’ but cannot achieve a pragmatic solution due to organisational (inadequate and unsuitable role structures) compounded by technological limitations (Alan and Leidner, 1999).

3. NAVIGATIONAL TRAILS

Developing this mechanism further it becomes possible to reduce complex navigational trails to sequences of words from which patterns may be induced via suitable neural packages to identify potential study routes indicative of demand driven training material. One caveat of this, is the breadth and depth of the original indexed web site – it needs to be sufficiently well indexed and substantial to encourage such exploration. Again this requires skilled indexers to establish the initial web engine and elicit ‘buy-in’ from the users. There is also the need to take into account the establishment of a market culture to provide a ‘value’ for information and to foster the development of a ‘trade’ in information (See Figure 2).

4. CONTEXTUAL ISSUES

Organising a central index of knowledge is well established in document management systems including librarian type support features. So that broader terms, narrower terms, related terms, glossaries and many other terms have become well established techniques for classifying and searching (Rowley, 1996). However, such centralised indexing will only

organise the structured information. An enterprise knowledge portal needs to adopt both structured and unstructured information.

4.1 Connectivity and its benefits

A corporate memory infrastructure offers dynamic, highly flexible control and provides the 'perspective' or filtered contextual view which is necessary to focus on ones viewpoint and locate that information or skill.

For example, take the index of a document and the index of a different document. Now take the index of the index and locate those pages of 'connected' information. Indexes themselves become content (meta-data). You can have system indexing (e.g. table of contents, glossaries etc) or user defined indexing (e.g. popularity, bookmark, myviewpoint etc).

The term indexing is often misleading – 'connectivity' is more apt. You can connect roles to roles, roles to resources, groups of roles to …to … etc. The challenge is to enable features which promote this 'connectivity' benefit. This enables the analyst in the field to access and be aware of a vast 'corporate memory' – to be connected with other analysts. Allied with the skills of the analyst this becomes formidable.

By monitoring criteria including web page visitation and index navigation of a corporate connectivity network (Li, 1998), it is possible to develop new perspectives (corporate experience) which represent new indexes.

4.2 The evolution of different organisations

With regard to information and knowledge transfer, the different organisations can be scaled in terms of their evolution:

Scale 1	Traditional paper based , postal, CDROM, room/dept based delivery
Scale 2	Emerging electronic media based channel delivery (eg web, BTV)
Scale 3	The 'Virtual' Training Organisation (Cybercorp)
Scale 4	The 'Virtual' Knowledge Organisation (Cybercorp)

Virtual in this context means a digital network akin to a nervous system complementary to the skills of people to amplify their talent by providing 'awareness' and 'feedback'. If one converts physical based media to electronic form and implement a web site or similar delivery channel then you achieve scale 2 – the Delivery Organisation or Document Company (Ginsburg and Kambil, 1999).

To achieve scale 3 and ultimately scale 4 requires an additional infrastructure. This must provide the following strategic characteristics:

- Analysis (Packaging or Modelling)
- Interaction (Tutor or Mentor)
- Feedback (Appraisal)
- Communication (Input and Output)
- Collaboration (Team grouping)

The infrastructure is comprised of an extensive list of features. Different combinations of these features provides the flexibility to support the different mindsets of a training organisation and/or a learning organisation. Both the training organisation and the learning organisation share these five characteristics. In addition, the learning organisation exhibits

additional strategic characteristics. The use of a database to support this infrastructure provides the scalability and required integration.

5. THE TRAINING ORGANISATION

A combination of features to support a training organisation would include:

- Course management
- Study routes
- Assessment
- Progress Tracking
- Mentoring
- Training Administration
- Support for different channels and media types
- Task scheduling
- Conferencing
- Chat-rooms
- Distance Learning Support
- Training manuals on demand
- Personalised training news alerts
- Learning group management
- Training bookmarks
- Training study management
- Training calendars
- Training reference source
- Shared glossaries
- Personalised training catalogues

Much will depend on the organisation, its size and trading activities. Moreover, this would also be influenced by the extent of its structured training programme and technology utilisation and networking capabilities.

6. THE LEARNING ORGANISATION

In the case of a learning organisation, knowledge management issues become relevant in terms of leveraging knowledge and knowledge sharing (Pelton, 1999). A knowledge strategy may be mapped to a business strategy through the use of technology, but consideration must be given to other strategic issues (O'Leary, 1998).

There is a combination of features, albeit different, which provides the infrastructure learning organisation. These features can be categorised as to their strategic benefits:

- Competency
- Culture
- Productivity
- Responsiveness
- Innovation

6.1 Competency

Competency would relate to knowledge dissemination, delivery channels, different modes such as on-the-job, on-line training, distance learning. Additionally, this would include browse i.e. speed reading, uncovering resources and requirements, together with study

(tutoring) and apprentice (mentoring). The development of skills and familiarity with business processes which includes dealing with technological, political and human culture.

6.2 Culture

Good knowledge availability should be the norm, not the exception, so people will realise the benefits and utilise knowledge and systems. Overcoming human barriers by ease of use (simplicity) and worthwhile (self-interest) and will make a person's job easier. Knowledge management is the interface of tacit and explicit knowledge (packaged in reusable, searchable form). The tacit form is where information is used after learning. Effective knowledge management requires effective (top) aligned business strategy/culture (not just technology) but a behavioural aspect also. While knowledge management techniques and tools enhance discovery and delivery of critical information and training, a business process should be present alongside any other business processes to continually improve staff skills.

6.3 Productivity

The capturing and sharing best practice can be directly related to productivity. This also includes capturing and categorising knowledge (increase the extent of shared 'packaging'). Moreover, ease of use and usefulness of systems are particularly important for adoption by site and head office staff. The reuse, displacement, replication (reduce duplication of effort) from one business process to another during the construction process. The discovery of (new trends, new ways of achieving objective, corporate 'lost' memory) may add value by applying found knowledge to new processes and problems.

6.4 Responsiveness

Being able to access correct information when needed (what and when) is particularly important in construction. Therefore making information and ideas available through a corporation may well improve efficiency and effectiveness. Construction organisations may be able to establish faster responses to changing market conditions, call centre support levels, forwarding, escalation, prioritisation, failure analysis, training profile based on market demand, on-line marketing and so on. Problem Solving to focus on the customer solution and the co-ordination of activities (accumulate information: who,what,where,when,why) would facilitate response to customer events in normal and unexpected scenario, and generally improve decision making.

6.5 Innovation

Innovation may embrace several issues. The discovery and nurturing of new ideas may spawn knowledge activities which can be mapped to specific strategic goals.
Personal collaboration/co-create (groupware) may be structured to achieve specific objectives (goals) or to resolve issues generally, which may be networked to include virtual teams or contact networks.

7. ACHIEVING SUCCESS IN KNOWLEDGE MANAGEMENT STRATEGY

Competitive advantage will be influenced by competence, innovation, productivity, responsiveness. This will also involve bringing together combined expertise in a co-ordinated manner in a remote and unpredictable context. Any electronic tool must share project management features and allow each individual or group to contribute progress reports, quickly resolve hot issues (eg delays, resource reallocation, emergency events, identify bottlenecks (critical points) and identify skills with roles by maintenance of a skills asset catalogue. Exceptional events could be mapped to the organisational skills catalogue to

provide best response. Members may be ‘connected’ by a videoconferencing ‘network’ to foster familiarity and non-verbal communication during ‘hot’ problem solving.

Access to documents is important, as is access to the right people in making a decision at the right time (an expertise network map is a valuable derived knowledge asset) within the right communication medium. Real-time collaboration enhances shared knowledge by engendering trust, familiarity, comfort factor, and communicates some information more fully and makes consensus building faster and more efficient. Knowledge management may involve the co-ordination between different companies where knowledge is not bounded to a single company. This may include contracting companies in the supply chain in addition to external parties to a project.

8. THE DIFFERENT TYPES OF ENTERPRISE LEARNING

Learning will vary across enterprises indifferent ways. However, a knowledge portal must learn in many different ways; it must record and communicate the results of its learning. This will encompass different techniques with their own related issues. Identified forms of learning would include:

- Learning by Reinvention
- Learning Teams
- Team Problem Solving
- Simulation and Prototypes
- Experimentation
- Customer Observation
- Benchmarking
- Facilitated Workshops
- Workout Sessions
- Quality Circles
- Brainstorming
- Enterprise Modelling
- Demonstration Projects
- Study of Successes and Failures
- Scenario Exploration
- Counterintuitive Learning
- Cross-communication of Learning
- Conferences to Exchange Experience
- Industry Seminars
- Computerised Representation of Procedures
- Expert Systems (and Neural Nets)
- A Knowledge Infrastructure

The extent of adoption of the above would be dependent on an enterprise’s maturity and commitment to the learning process.

9. DETERMINATION OF STRATEGIC GOALS

The five strategic goals, competency, culture, productivity, responsiveness and innovation are determined by two dimensions:

a) Collaboration, Communication and Connectivity

Interaction during knowledge creation, sharing and applying

b) Organisational Scale

Scalable knowledge - individual competency gained at workshops, conferences and training sessions must be leveraged through the corporation by suitable 'packaging'

Technology as defined by culture, techniques and tools can be harnessed to benefit from these two dimensions, which would be more difficult and would take longer in a non-technology culture. The evolution of such a virtual culture may therefore be seen as a layered strata (See Figure 3).

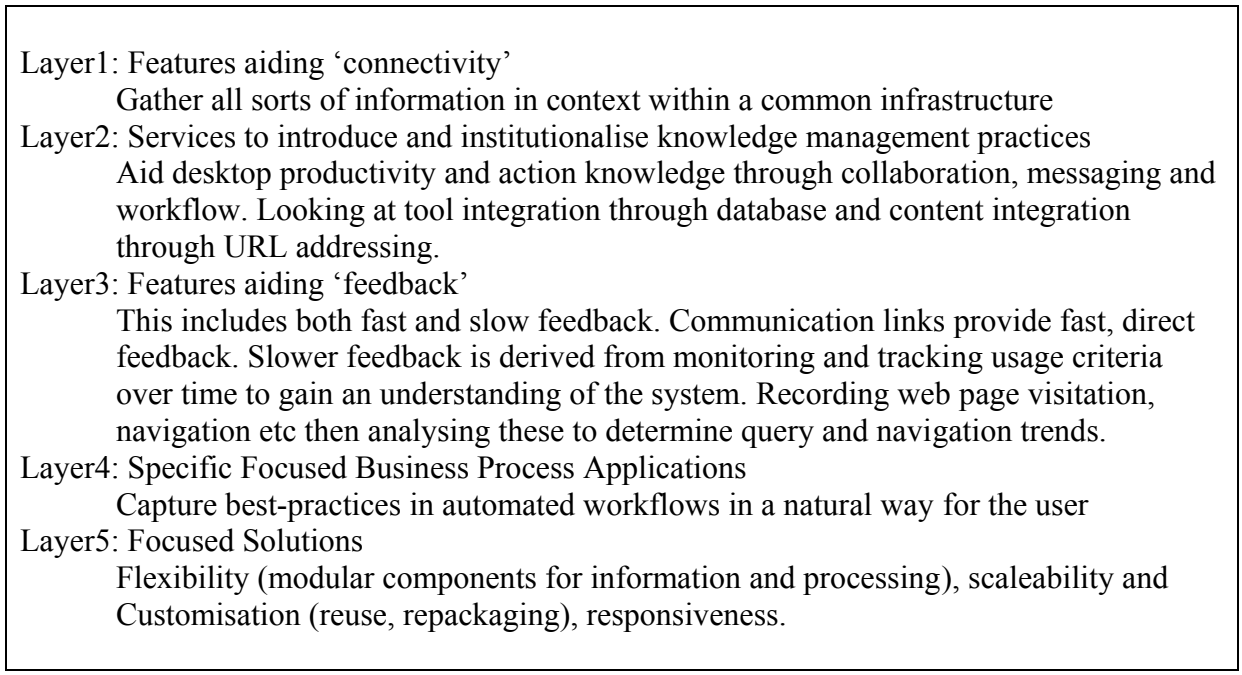

Figure 3. The Learning Platform Tool (as a layered architecture)

10. CONCLUSION

Organisations within the construction environment need to be aware of knowledge issues which impact on their business operations. This also includes the pragmatic considerations in establishing a technical architecture for the realisation of a knowledge portal for the construction process. Appropriate technology needs to be used in a practical way to utilise the knowledge of individuals, and the enterprise, to promote efficient and effective working. Additionally, training and learning aspects need to be realised and acted upon as part of organisational culture. In turn, this will promote the opportunity to enhance the realisation and utilisation of knowledge in order to promote competitiveness, profitability and survival in future markets.

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