

GRAPHICAL CONVEYANCE OF KNOWLEDGE AMONGST CONSTRUCTION SMES

CHARLES EGBU¹, CYNTHIA CHINTIAN LEE¹, DAVID BOYD², HONG XIAO²,
EZEKIEL CHINYIO²

¹School of Built and Natural Environment, Glasgow Caledonian University, Glasgow;
Email: c.egbu@gcal.ac.uk

²School of Property and Construction, University of Central England, Birmingham.

ABSTRACT

Much of construction work is project-based, short-term and task-oriented; promoting a culture of continuous learning is inhibited. Very often, specialist and technical knowledge is not shared laterally, neither between fellow site personnel nor organisations. This is especially so for tacit knowledge, which site managers gain and use in solving their complex day-to-day problems. A research on knowledge management amongst construction SMEs is discussed. This study uses storytelling as a mechanism for unravelling the tacit knowledge of experienced site managers. As stories are told, wider learning is extracted through reflection and debriefing. The intention is to share this learning, first within the participating SMEs and subsequently to the construction industry at large. The research is at the same time exploring different ways in which any knowledge obtained can be shared or transferred. In this regard, this paper concentrates on representing stories or their lessons graphically. The paper reports two cases where two separate lessons from two different site managers were obtained by means of artistic impressions. Through subsequent feedback sessions with these site managers, the researchers were able to establish that the graphics had captured the hitherto tacit knowledge of these site managers. As well as capturing knowledge, the site managers opined that the graphics could be used to transfer information to others.

Key Words: Communication, Graphics, Information, Knowledge Management, Storytelling, Visualisation.

INTRODUCTION

Learning takes place when knowledge is acquired to either solve problems or provide new and creative insights (Goh, 2002). Learning can occur either within or across organizations. Meanwhile, much of construction work is project-based, short-term and task-oriented, which inhibits continuous learning. Very often, specialist and technical knowledge is lost from one project to the next and not shared among project team members. This is especially so for tacit knowledge, which is very hard to capture and manage (Augier, 1999; Scarbrough et al., 1999).

In the absence of relevant knowledge members of an organization are unable to refer to each other's work, mistakes are repeated, resources are wasted and, the organization finds

itself reinventing the wheel (Robertson, 2002; Flar, 2002). Given the high cost of construction production, it is prudent in terms of time and economy for construction organisations to capture, transfer and reuse previous relevant project knowledge for improving project performance. The need for project participants to share knowledge for wider benefits has never been greater (Whelton *et al.*, 2002). Thus, effective means of capturing existing tacit knowledge were explored in a research being discussed in this paper.

There is often a strong tacit dimension concerning how to use or implement explicit knowledge. However, there are relatively few methods and tools to capture this tacit knowledge proactively, and approaches to wider knowledge dissemination across organisational boundaries are mainly ad hoc (McAdam & Reid, 2001). A panacea for construction 'Small and Medium Enterprises' (SMEs) to exploit their tacit knowledge base was thus explored in this research and explained in this paper.

KNOWLEDGE MANAGEMENT

Knowledge is a by-product of learning, and it is personal to an individual (Orange *et al.*, 2000). Knowledge involves the creation, processing and possible use of information in the mind (Ash, 1998; Kirchner, 1997), and knowledge management concerns these activities (Kazi *et al.*, 1999). The application of knowledge involves interpretation and reflection (Davenport *et al.*, 1998; Kirchner, 1997; Frappaolo, 1997).

From an outcome-based perspective, organisations manage knowledge to create business value and generate competitive advantage (Tiwana, 2000). Integratively, knowledge management is any process or practice of creating, acquiring, capturing, sharing and using knowledge, wherever it resides, to enhance learning and performance (Scarborough *et al.*, 1999).

Knowledge management is vital for efficiency in project delivery and improving organisational competitiveness (Egbu, 2000a; 2001). Knowledge management also promotes innovation and business entrepreneurship, helps in managing change, and emancipates and empowers employees (Nonaka and Takeuchi, 1995; Egbu, 2000b; McAdam and McCreedy, 2000; DTI, 2000).

The subject matter of knowledge management is broad (Depress and Chauvel, 1999). This paper does not attempt to discuss knowledge management exhaustively. However, some of its concepts are elaborated below to provide the context of this paper.

Explicit vs. tacit knowledge

The construction industry is essentially an information processing industry (Aish, 1999); where knowledge acquired from previous projects informs the execution of current and future projects (Conheeney *et al.*, 2000). A large amount of this knowledge is held tacitly in the minds of personnel. This type of knowledge is highly personal and hard to

formalize, thus making it difficult to communicate or share with others. Subjective insights, intuitions and hunches fall into this category of knowledge.

Tacit knowledge is deeply implicit in each individual's actions and experiences, as well as in the ideals, values, and emotions that they embrace or exhibit. Tacit knowledge is often hidden and cannot be represented easily, not even by electronic mechanisms (Martensson, 2000). The subjective and intuitive nature of tacit knowledge makes it difficult to process or transmit in any systematic or logical manner. For more efficient practices, it is vital for construction personnel to access both intra-organisational knowledge that resides with their colleagues, and if possible, inter-organisational knowledge from others.

Contrary to tacit knowledge, explicit knowledge can easily be captured and expressed in words, numbers, scientific formulae, product specifications, manuals, universal principles, etc. Explicit knowledge can be transmitted readily across individuals in a formal and systematic manner. It can also be processed and transmitted electronically, and stored in databases.

However, explicit knowledge can be transformed into tacit knowledge and vice-versa. In this regard, four modes of knowledge conversion were discussed by Nonaka and Takeuchi (1995), i.e. socialisation, externalisation, combination and internalisation. The relationships between these four modes are defined below and as shown in Figure 1:

	Tacit Knowledge	To	Explicit Knowledge
Tacit Knowledge			
From	Socialisation		Externalisation
Explicit Knowledge	Internalisation		Combination

Figure 1: Modes of Knowledge Conversion (Nonaka, 2004)

Socialisation – The sharing of experiences such that tacit knowledge embodied is passed between individuals, or between individuals and organisation through the development of culture and shared mental models.

Combination – This is a conversion of explicit knowledge held by individuals into explicit knowledge at the organisational level, then subsequent conversion of organisational knowledge back to the individual in different forms.

Externalisation – The process whereby a body of knowledge is formalised through articulation and systemisation within the organisation.

Internalisation – Explicit knowledge can be transferred to tacit knowledge in people through a process of internalisation. The conversion of explicit knowledge, whether at the individual level or organisational level into tacit knowledge in the form of individual know-how and organisational routines is through a translation of theory into practice.

Knowledge sharing

Knowledge sharing involves the transfer of knowledge from one source to other(s). This is not a case of linear information transfer but a process of ‘sense making’ (Sparrow, 2001). The knowledge transfer process is ultimately a human-to-human process that is inherently interactive and dynamic.

During the very process of knowledge transfer, a more robust representation of knowledge in its intended form and meaning may be needed so as to capture and correctly convey the originator’s knowledge (Shariq, 1999). Electronic and other devices might be used as tools for transferring knowledge, however, the task is essentially a flow of knowledge between two or more persons. Knowledge may thus be transformed in the course of sharing. Some of the avenues in which knowledge is shared and which are applicable in this discourse are: use of stories and graphics.

Knowledge sharing through storytelling

The conversion of information into knowledge is best accomplished through social actors, but these social actors are slow in converting data to information (Bhatt, 2001). Thus, knowledge management is best carried out through optimization of technological and social subsystems.

Sometimes knowledge transformation and dissemination takes place through people telling stories about the events they have experienced (Kakabadse, et al., 2003). The storytelling approach has been identified as one mechanism that may be suited to the transfer of tacit knowledge (Thomas, 2001; Reamy, 2002).

One of the most important characteristics of stories is that they convey not only information but also meaning and knowledge (Post, 2002). Stories exist in the realm of knowledge and are particularly suited to knowledge management instead of information management (Reamy, 2002). Important features of stories identified by Thomas (2001) are:

- 1) Each story conveys knowledge; not only about one or more “subject matters” but also about the teller, the context and the rest of the communication.
- 2) The amount of knowledge that is activated in the mind of the listener or reader is far greater than the relatively small amount of information that is explicitly stated in the story.

Stories can be conceptualised as a form of “virtual reality” and work well as a transmitter of tacit knowledge that allows the reader and listener to simulate a multidimensional and multi-modal experience rich in emotional and social context (Thomas, 2001). Some

evidence has shown that a story context helps people to recall and process more logically (Thomas, 2001).

Visual representation of information

Visualisation is a cognitive activity we engage-in, and by which we obtain insight (Spence, 2001). Visualization makes communication more effective and accessible. For more effective results, visualisation is best combined with a model driven (integrated) construction environment. Simulation is an important tool that helps the construction manager to analyse productivity measurement, risk analysis, resource allocation, site planning, etc. Moreover, simulation in construction will improve feasibility, planning and scheduling (Amor et al., 2002; Sarshar et al., 2000).

In representing the deep knowledge within stories, two different ways of using multimedia to capture the richness of stories have been identified by Reamy (2002). The first is to create a movie that captures the story and/or exemplifies the story in a way that goes beyond simply a talking head telling a story. The second is to create a multimedia representation of the elements of the story and their relationship. Through the use of context, the information contained in stories can be seamlessly incorporated into the story and because it is easier for humans to remember knowledge rather than strings of unrelated bits of information, stories are also used as a medium to codify knowledge.

Supporting reasons given by Thomas (2001) is that our visual system tends to extract edges and is responsive to changes such as motion or change in illumination. Our auditory system is sensitive to changes in loudness, pitch, position, etc. Similarly, we are tuned to pay attention to extremes and transitions in social and emotional situations. Stimuli that are presented multi-dimensionally are typically encoded multi-dimensionally and tend to be better recalled than stimuli that are presented in one modality only. But, in a story, the reader and listener is not a passive recipient of stimuli; instead they are creating a multidimensional experience. Also supported by Reamy (2002), our brains are designed to work better when more than one sensory channel is activated by incoming stimuli. If multimedia presentation activates more parts of the brain, two things happen: people can pay attention better and they can remember better. Descriptions in text in a story allow many interpretations and a greater degree of empathy (Thomas, 2001). Unless the content of stories is represented appropriately, ambiguity and vagueness can arise and the communication of tacit knowledge may not be conveyed.

In construction, it is essential to rely on past project knowledge and information when dealing with new projects. Communication between the construction parties, especially in the design stages of construction, relies mainly on drawings and specifications.

RESEARCH METHODOLOGY

This paper is based on a study, which tracked a number of projects, that were ran by some construction SME organisations. Each project was studied for six months and

explored the suitability of knowledge management techniques in the different commercial and professional environments. The projects were either in the development, design or construction phases. Although several aspects of knowledge management were studied, this article concentrates on the graphical capture of knowledge.

Construction practice communicates substantively by means of the spoken language. This form of communication is rich in meaning because of nuances of delivery and body language and context, which provide many dimensions of information that is useful for practice. This multi-dimensional world of oral communication conveys much of tacit knowledge and also the ability to transfer it. Therefore, it was decided that verbal communication be used as a basis for capturing past events in this research. As this research concerns learning from tacit knowledge, it was primarily focused on the concepts of 'socialisation' and 'externalisation' as illustrated in Figure 1.

Research design and tools

A tool for knowledge management was developed for capturing data from some construction site managers. This involved two main operations:

1. The recounting of past events; and,
2. Reflection and abstract conceptualisation of these events through debriefing.

28 site managers from 12 SME organisations were involved in the study, coming from organisations that included general contractors, specialist contractors and consulting companies.

Once a week, the research participants recorded stories of problem-solving events, which they had experienced. The participants were encouraged to select events that were useful for learning; i.e., events that were challenging, successful, worrying, complicated, difficult, frustrating, or annoying.

A set of structured but open questions was provided to help the participants in recording their stories. The use of audio diaries in this task minimised disruptions to the participants' daily work, and encouraged their participation and cooperation. Nearly three hundred audio diary entries were recorded and their stories yielded rich qualitative data.

After about four diary entries, the storyteller was debriefed to analyse for learning from these stories and to provide a deeper interpretation of the events. The debriefing sessions were thus structured to facilitate the data analysis. The structuring was done with reference to principles discussed by Pearson and Smith (1985). Over ninety debriefings were conducted with the research participants.

VISUALISED KNOWLEDGE SHARING

Two cases are considered here from within the many stories collected and their associated debriefings. While the research encourages construction SMEs to develop their KM procedures, it also acknowledges there are different ways of doing so,

especially in terms of knowledge transmission. While IT is very effective and efficient in capturing and transmitting knowledge, this avenue is still undeveloped in SME site settings. Before this channel picks-up, and in conjunction with it, other forms of knowledge transfer are also viable. One of these, which was explored in the research, is the use of graphics. The two case studies elaborate on it.

Case No.1

This case concerns theft. The construction site involved adjoined a road, railway line and factory premises on three of its sides. Although security measures were put in place on this site, a break-in was discovered on a fateful morning wherein computers, fax machines, and even kettles and other personal items were stolen. The effect of the incident was to interrupt the daily flow of work.

Through the debriefing session that followed, the wider social dimension of theft was highlighted. If there were more police patrols around the site, the theft might not have happened. Notably, the cost of engaging night shift security is very high. The provision of better office cabins with higher security and/or CCTV can improve site security, but that comes with a high premium too. If an organisation reflects these aspects in a bid, they could become uncompetitive.

The researchers and participant agreed that, a more reliable risk assessment and financial analysis were needed to decide what security measures are taken on a particular construction site.

Graphical capture of greater learning

In the course of the research, an attempt was made to capture the foregoing scenario or lessons deriving from the story. This effort involved a sister department with speciality in visual communication. Furnished with recordings and transcripts of the story and debriefing, the associating department was asked to represent an aspect of it visually. An outcome of this quest is portrayed in Figure 2, which shows three graphics aimed at preventing theft on site.



Figure 2: Graphical warnings to promote security on sites

In Figure 2, the suggestion is that key holders and signage on clothing could be used to remind operatives to be vigilant and protective. Posters at strategic locations on site could also be used to remind workers of the possibility of theft. Obviously, there is no 'one-fix-it-all' solution. A combination of methods may be necessary for spreading the news.

Case No. 2

The second story concerns health and safety. P is a site manager on a project of building some apartments. A subcontractor's bricklayer redeemed hardhat unnecessary and refused to wear it. He had been dismissed from other sites of P's company before for the same reason. P gave him a choice: whether wear the hard hat or leave the site. The bricklayer behaved very childishly and tended to smirk it off. P told the subcontractor that it was his responsibility for the safety of his workforce. But the subcontractor said he saw no reason why his bricklayers needed to wear a hardhat and if P insisted, they would pull out of the site. In the end, P had no alternative but let them go because he would like to and prevent any possible accidents on his site.

Because of this, one week was lost in order to find a replacement, but health and safety discipline was maintained on the site. During the debriefing, the site manager attributed this to the fact that subcontractors started to take more risks when they were under time pressure and that subcontractors were selected mainly based on their price instead of overall performance. The wider learning from this event is that the health and safety

standard should never be compromised and the workforce should have proper health and safety training and induction before starting work on site. And subcontractors' performance needs to be monitored and assessed.

To highlight the importance of health and safety and intensify people's awareness of it, it is suggested that posters like the one in the figure below would work, and some specifically designed stickers may also catch people's attention and remind them about health and safety issues on site.



Figure 3: Graphical warning to promote health and safety on site

Feedback on the graphics

The graphics in Figures 2 & 3 were shown to the site managers who provided the stories on which the graphics were developed. This feedback was sought, to determine if the graphics had either captured their stories or teased out information from those stories very well. The site manager was generally satisfied with the knowledge representations. Other site managers were shown the same graphic and asked to tell what message it conveys. Their comments were equally satisfactory.

However, the site managers opined that other forms of knowledge sharing could be used. Avenues suggested included the use of newsletters, discussion forums, pictorial representation, etc. The use of these suggested avenues is being explored by the researches. Also, the graphical capture and sharing of knowledge is being developed further.

CONCLUSION

When both tacit and explicit knowledge interact, new knowledge and innovation can often emerge (Ingirige et al., 2002). Knowledge sharing will minimise the knowledge loss that will result in the event of a straightforward transfer of tacit knowledge to explicit forms. McDermott (1999) argues that IT tools alone cannot effectively perform knowledge conversion, unless certain other conditions such as trust, face-to-face contact, time to interact between participants and creation of a common language are in place. Graphical representation of tacit knowledge transfer presents an opportunity for interaction and creation of common language.

In this research, storytelling has proved to be a useful tool in capturing tacit knowledge and graphical representation of information assist the dissemination of tacit knowledge.

REFERENCES

- Aish R., (1999), Migration from an Individual to an Enterprise Computing Model and its Implications for AEC Research, Berkeley-Stanford CE & M Workshop: Defining A Research Agenda, Stanford.
- Amor R., Betts M. Coetzee G., Sexton M., (2002), Information Technology for Construction: Recent Work and Future Directions, Electronic Journal of Information Technology in Construction, Royal Institute of Technology, Stockholm, Sweden (cited 13 October 2002), < <http://itcon.org/2002> >
- Ash J., (1998), Managing knowledge gives power, Communication World, Vol.15 No. 3, pp. 23-26
- Augier, M. And Vendelo, M.T., (1999), Networks, Cognition and Management of Tacit Knowledge, Journal of Knowledge Management, Vol 3(4), pp. 252-261.
- Bhatt, G.D., (2001), Knowledge Management in Organisations: examining the interaction between technologies, techniques and people, Journal of Knowledge Management, Vol. 5 No. 1, pp. 68-75, MCB University Press
- Conheaney K., Stephenson P. and Griffiths A. (2000), Issues In Knowledge Transfer Within A Construction Training And Learning Organisation, Proceedings of the International Conference on Construction Information Technology (CIT2000), G. Gudson ed., Reykjavik, Iceland, 28-30 June, Vol. 1, pp.229-240
- Davenport T.H., De Long D.W., and Beers M.C., (1998), Successful knowledge management projects, Sloan Management Review, Vol. 39 No. 2, pp. 43-57
- Department of Trade and Industry (DTI), (2000), Excellence and opportunity a science and innovation policy for the 21st century, The Stationery Office, London
- Despres, C., and Chauvel, D., (1999), Knowledge Management(s), Journal of Knowledge Management, Vol. 3, No. 2, MCB University Press
- Egbu, C.O. (2000a) The role of IT in strategic knowledge management and its potential in the construction industry. UK National conference on Objects and Integration for Architecture, Engineering and Construction, 13-14th March 2000, BRE, Watford, UK

- Egbu, C.O. (2000b) Knowledge management in construction SMEs: coping with the issues of structure, culture, commitment and motivation, ARCOM Sixteenth Annual Conference 2000, Glasgow Caledonian University, pp 83-92
- Egbu, C.O. (2001) Knowledge management in small and medium enterprises in the construction industry: challenges and opportunities. *Managing Knowledge: Conversation and Critiques*, Proceedings of an international conference convened at the University of Leicester, UK, 10-11th April 2001
- Flar, A.A. (2002) Implementing a Solution to Retain Knowledge. *Knowledge Management Review*, 4(6), pp 30-33
- Frappaolo C., (1997), Finding what's in it, *Document World* Vo. 2, No. 5, pp. 23-30
- Goh, S.C. (2002) Managing effective knowledge transfer, *Journal of Knowledge Management*, 6(1), pp23-30
- Goh, S.C., (2002), Managing effective knowledge transfer, *Journal of Knowledge Management*, 6(1), pp 23-30, *Handbook of industrial innovation*, Aldershot: Edward Elgar, pp 310-324
- Ingirige B., Sexton m., and Betts M., (2002), The Suitability of IT as a Tool to Facilitate Knowledge Sharing in Construction Alliances, *International Council for Research and Innovation in Building and Construction*, CIB w78 conference 2002, pp. 1-8, Aarhus School of Architecture, 12-14 June 2002
- Kakabadse, N.K.; Kakabadse, A. and Kouzmin, A., (2003), Reviewing the knowledge management literature: towards a taxonomy, *Journal of Knowledge Management*, 7(4), pp75-91
- Kazi, A.S., Hannus, M., and Charoenngam, C. (1999), An Exploration of Knowledge Management for Construction, *Proceedings of the 2nd International Conference on CE in Construction*, CIB Publication
- Kirchner S.R., (1997), Focus on: database integration and management for call centres, *Telemarketing*, Vol. 16, No. 2 pp. 22-24
- Martensson M., (2000), A Critical Review of Knowledge Management as a Management Tool, *Journal of Knowledge Management*, Vol. 4, No. 3, pp. 204-216, MCB University Press
- McAdam, R. and McCreedy, S., (2000), A critique of knowledge management: using a social constructionist model, *New Technology, Work and Employment*, 15:2, pp 155-168
- McAdam R., and Reid R., (2001), SME And Large Organisation Perceptions Of Knowledge Management: Comparisons And Contrasts, *Journal of Knowledge Management*, Vo. 5(3), pp. 231-241
- McDermott, R., (1999), Why Information Technology Inspired But Cannot Deliver KM, *California Management Review*, Vol. 41(04), pp. 103-117
- Nonaka, I. & Takeuchi, H., (1995), *The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation*, Oxford University Press: New York
- Nonaka, I., (2004), A Dynamic Theory of Organizations. In Starkey, K.; Tempest, S. and McKinlay, A. *How Organizations Learn: Managing the search for knowledge* (2nd ed), Thomson, London; pp 165-201.
- Orange G., Burke A., Boam J., (2000), The Facilitation Of Cross Organisational Learning And Knowledge Management To Foster Partnering Within The UK Construction Industry, *ECIS 2000*, (<http://is.lse.ac.uk/b-hive/publications.htm>)

- Pearson, M. and Smith, D. (1985) Debriefing in experience-based learning, *Reflection: Turning Experience into Learning* (Edited by Boud, D., Keogh, R. and Walker, D.), Kogan Page, London, 69-84
- Post, T. (2002), The Impact of Storytelling on NASA and EDUTECH, *Knowledge Management Review*, 5(1), pp 26-29.
- Reamy T., (2002), Imparting Knowledge Through Storytelling, *KMWorld*, (cited 22 October 2003), < <http://www.kmworld.com> >
- Robertson, S. (2002) A tale of two knowledge-sharing systems. *Journal of Knowledge Management*, 6(3), 295-308.
- Sarshar M., Betts M., Abbott C., Aouad G., (2000), *A Vision for Construction IT 2005-2010: Two Case Studies*, Engineering Construction and Architectural Management, Blackwell Science Ltd, UK
- Scarbrough, H., Swan, J. and Preston, J. (1999), *Knowledge Management: A Literature Review*. London: Institute of Personnel and Development.
- Shariq S.Z., (1999), How does knowledge transform as it is transferred? Speculations on the possibility of a cognitive theory of knowledgescapes, *Journal of Knowledge Management*, MCB University Press.
- Sparrow J, (2001), *Knowledge Management in Small Firms*, *Knowledge and Process Management*, Vol. 8(1), pp. 13-16
- Spence, R., (2001), *Information Visualization*, Harlow, England, Addison-Wesley
- Thomas J.C., (2001), Story-Based Mechanisms of Tacit Knowledge Transfer, *ECSCW 2001*, Seventh European Conference on Computer Supported Cooperative Work, 18-20 Sept 2001, Bonn, Germany
- Tiwana E., (2000), *The Knowledge Management Toolkit*, Prentice Hall Inc., New Jearsey
- Whelton, M., Ballard, G., and Tommelein, I.D., (2002), Knowledge Management Framework for Project Definition, *Electronic Journal of Information Technology in Construction*, Vol. 7 Royal Institute of Technology, Stockholm, Sweden (cited 22 October 2003), <<http://www.itcon.org/2002/13>>