

Reciprocal and complementary knowledge conversion in a work integrated learning collaboration

Ashley Holmes, School of Creative and Performing Arts, CQUniversity Australia,
a.holmes@cqu.edu.au

Abstract

This is a reflective discussion paper that uses a well-known theory to analyse the processes of knowledge conversion (Nonaka, & von Krogh 2009) in the case of a team-based work integrated learning project involving an educational institution (the contractor) and an industry partner (the client). Advanced level undergraduate student teams on behalf of the contractor were involved in the development of interactive multimedia plant maintenance training manuals for the client. A synthesis of media modalities afforded by the interactive multimedia artefacts helped overcome a knowledge conversion risk identified in the client's workplace. The opportunity for students to authentically apply skills that had hitherto been developed only in the context of learning outcomes and course assessment, helped overcome educational risks identified as gaps between graduate and employer expectations. The client and contractor scenarios are characterised as reciprocal and complementary examples of knowledge transfer: one, converting knowledge held by experienced professionals from the tacit to the explicit; and the other, introducing an experiential or tacit dimension to a mostly explicit formal learning framework. A review of literature is conducted in search of evidence regarding efficacy of knowledge conversion using video and digital media with the conclusion that this is a field ripe for original research.

Key words: work integrated learning, knowledge, conversion, tacit, explicit, stories, digital media, training

This article has been peer-reviewed and accepted for publication in *SLEID*, an international journal of scholarship and research that supports emerging scholars and the development of evidence-based practice in education.

© Copyright of articles is retained by authors. As an open access journal, articles are free to use, with proper attribution, in educational and other non-commercial settings.
ISSN 1832-2050

Introduction

In his 2004 book, *Lost Knowledge: Confronting the Threat of an Aging Workforce*, David W. De Long highlights threats to organisations similar to those that had been identified in risk assessment audits at the Queensland Alumina Limited (QAL) refinery in Gladstone, Queensland. In that text De Long discusses just the sorts of strategies that were being employed in the Pump Maintenance Division in 2007 when a Business Improvement Coach from QAL approached the Head of the Bachelor of Multimedia Studies (BMS) program at CQUniversity Australia (CQU). The coach wanted to find out if the university could assist with a project involving

compilation of extant process documentation with video documentation of critical pump maintenance procedures yet to be acquired. It was envisaged that the result would comprise one or more interactive multimedia training manuals.

To address the gap between the expectations of prospective employers and aspiring digital creatives that is documented in a 2010 report produced by the ARC Centre of Excellence for Creative Industries and Innovation (Haukka, 2010, p. 14), the capstone experience in the BMS involves teams of students working collaboratively on projects arising from the real needs of industry partners. The project that the QAL coach proposed was immediately attractive as a work integrated learning (Keleher, Patil, & Harreveld, 2011) opportunity for final year undergraduates. Consistent with the influential engagement theory of Kearsley and Schneiderman (1998), it had the potential to “involve active cognitive processes such as creating, problem-solving, reasoning, decision-making, and evaluation” and to intrinsically motivate students. According to the theory such motivation arises in part from the authentic nature of the project—in that it would be an ambitious challenge “meaningful to someone outside of the classroom,” and in part from the collaborative “team efforts that involve communication, planning, management and social skills” (Kearsley, & Schneiderman, 1998).

Detail about how two projects transpired from this initial contact, and a reflective analysis of the process from the points of view of the ‘client’ team (QAL) and the ‘contractor’ team (CQU) are the topic of a separate paper (Holmes, Kinslow, & Pope 2010). In this discussion the author wishes to focus on the two examples of knowledge conversion involved using Nonaka’s SECI model (1994) given that, it will be argued, one may be construed as primarily involving conversion from tacit to explicit and the other vice versa. It is also significant to the discussion that, as will be explained, both teams were reliant on information communication technology, and more specifically digital media, as vehicle for problem resolution. Research literature on the efficacy or otherwise of interactive, digital, audiovisual, media for the purpose of this kind of knowledge conversion will be surveyed in a concluding section of this paper.

Knowledge conversion theory

In the fields of knowledge management and organisational science the theory of knowledge conversion as proposed and modified by Ikujiro Nonaka and a number of collaborators over a period of 20 years has become “the single most influential and widely referenced theory” concerning knowledge creation (Hislop, 2009, p. 118). Notwithstanding there are critics of Nonaka, as listed in Gourlay (2006), it is proposed here to use his well-known Socialisation/Externalisation/Combination/Internalisation (SECI) framework (Nonaka, 1994) to analyse the knowledge conversion processes involved in the topical inter-organisational collaboration from the points-of-view of the client and the contractor.

The following précis of some of the fundamental epistemological tenets of Nonaka’s theory relevant to this discussion is based on a reiteration and summary of his theory published in 2009 (Nonaka, & Krogh, 2009).

It is clear that Nonaka owes some debt to Polanyi (1966, 1969), particularly the concepts of tacit and explicit knowledge. Tacit knowledge is that which is “unarticulated and tied to the senses, movement skills, physical experiences, intuition, or implicit rules of thumb” (Nonaka, & von Krogh 2009, p. 635). Explicit knowledge is uttered, codified, formalised, documented, and captured in images

and so on. Because explicit knowledge can be expressed in words and numbers, scientific formulate, specifications, manuals and can be digitised, stored and shared in the form of data, it is readily transferred. Like Polanyi, Nonaka says that tacit knowledge is acquired with little or no direct instruction. It is procedural and, “above all, practically useful.” After Maturana and Varela (1987) he says that “much of it is embodied and therefore tied to the senses and escaping any analysis through self-introspection” (Nonaka, & von Krogh, 2009, p. 641). Tacit knowledge can be difficult to express and indeed needs to be made explicit to some degree to be transferred. “Explicit knowledge has a universal character, supporting the capacity to act across contexts” (Nonaka, & von Krogh, 2009, p. 635). This is where his concept of knowledge ‘conversion’ is significant. It is also where he departs from Polanyi. Nonaka says,

According to Polanyi’s work, tacit knowledge/knowing is impossible to communicate to others through articulation and it ranges from knowledge for inherent physical functioning to the insights or inspiration needed for an act of creativity (Nonaka, & von Krogh, 2009, p. 640).

He points out that Polanyi resisted the notion of ‘purely’ explicit knowledge devoid of any tacit dimensions. Polanyi thought that explicit knowledge is always grounded in tacit knowledge (Nonaka, & von Krogh, 2009, p. 637). By contrast, Nonaka and von Krogh’s (2009) principle notion is that “tacit and explicit knowledge can be distinguished along a continuum” ranging from pure tacit knowledge to pure explicit knowledge; and that “knowledge conversion explains the interaction between tacit and explicit knowledge” (p. 635). Nonaka (1994) further departs from Polanyi in that he asserts that tacit knowledge has a ‘technical element’—characterised as know-how and, a cognitive element—characterised as the mental models that an individual uses to envisage what is and what ought to be.

Fundamentally “knowledge is justified true belief.” This may be altered through reflection and the capacity to act. Knowledge has both personal and social dimension. It loses some of its ‘tacitness’ through the process of sharing or “externalisation” through articulation. This process “becomes a basis for reflection and continuous action,” an idea that has resonance with theories of reflective practice. It has application in organisational knowledge creation, which is “the process of making available and amplifying knowledge created by individuals as well as crystallizing and connecting it to an organization’s knowledge system” (Nonaka, & von Krogh 2009).

Communicative acts involve alternation between the tacit and the explicit dimensions of knowledge. This occurs in four processes the names of which form the well-known SECI mnemonic: Socialisation; Externalisation, Combination and Internalisation. During socialisation the sharing of experiences converts tacit knowledge into new tacit knowledge. This involves observation, imitation, and practice. Nonaka and van Krogh (2009) say of socialisation, “tacit knowledge serves purpose as a foundation of social practice and foundation for innovation” (p. 644). The conversion of tacit knowledge into explicit knowledge is referred to as externalisation. This may be achieved through language: utterances, metaphors, analogies, concepts, hypotheses, models and images. The conversion of explicit knowledge to tacit is referred to as internalisation. It involves the embodiment of knowledge and may be conceptualised as learning by doing. It tends to be an individualised process. To shift from one explicit mode to another is referred to as combination. It might involve the synthesis of discrete concepts to form a more complex system. Sorting, combining, and categorising may reconfigure information. Knowledge may be exchanged and combined through media,

documents, meetings, and conversations. This process is characterised by formal learning and training.

In the organisational context this knowledge creation process is conceptualised as a spiral. Nonaka and von Krogh (2009) say these processes mutually enhance each other towards increasing capacity to act. Personal subjective knowledge can be brought together with other's knowledge so that the overall body of knowledge keeps expanding. The alternating forms enhance both the tacit and explicit elements. "Human creativity affords these alternating forms for the purpose of effectively interacting, discovering 'truth', justifying observations, defining problems and solving them" (p. 638).

Other authors have contributed to the depth of this theory, particularly with respect to transfer and retention of knowledge of more experienced workers. DeLong (2002) provides a topology of four distinct types of knowledge interaction in an organisation: human, social, cultural and structured. Human knowledge is explicit and tacit. It may be sentient (embodied) or cognitive (conceptual and abstract). Social knowledge is sometimes also referred to as 'social capital' and is largely tacit. Cultural knowledge reflects a collective understanding shared broadly across an organisation. Structured knowledge is that which is embedded in an organisation's systems. It is explicit and rule-based. Leonard and Swap (2005) characterise what they call "deep smarts" as "potent form of expertise" that it is "as close as we get to wisdom". Asserting that deep smarts cannot be gained from formal education alone, they suggest they can be thought of as 'know-how' (and often 'know-who') as opposed to 'know-what'. They propose that deep smarts can be nourished, are transferable and can be recreated. The big question is, how? DeLong (2004) describes four types of initiatives for retaining knowledge for the organisation: human resources processes and practices; practices to transfer knowledge; knowledge recovery initiatives; IT applications to capture, store and share knowledge. The following section of this article is a mini case study of an endeavour to implement these initiatives with a particular focus on the latter.

The QAL problem

Situated in Gladstone on the Central Queensland coast Queensland Alumina Limited is one of the world's largest alumina refineries, producing some 3.95 million tonnes of the world's best smelter grade alumina per year (QAL, 2010). This discussion focuses on the knowledge management and training practices of the pump maintenance crew of the digestion plant where bauxite ore is finely ground and then mixed into caustic slurry at high temperature and pressure. It is a hazardous industrial environment and the equipment is critical to the operation of the whole plant. In keeping with best practice knowledge management, plant equipment and its maintenance procedures are constantly subject to routine review and documentation and to risk management assessment.

Industry-based knowledge management programs institute a variety of methods of documenting and passing on organisational knowledge including: word of mouth; written procedures that instruct specific 'job safe procedures'; picture process maps that graphically outline information and chart process; 'work packs' that combine the technical and procedural detail of the written information with the observational acuity of the photo media; audiovisual instruction including video and digital multimedia presentation (Holmes, Kinslow, & Pope, 2010). However when a risk involving the imminent retirement of key senior maintenance engineers was identified, a way to secure the wisdom specific to maintenance of the critical

plant that the experts had accumulated over years of service was sought. It was envisaged that demonstrations of procedures that the experts themselves considered to involve most risk to plant or person should be recorded and that combining this with extant documentation into a readily accessible multimedia format maintenance manual could be the solution. This is the stage at which the QAL business coach contacted the CQU multimedia academic.

The CQU problem

CQUniversity has campuses in the regional cities of Bundaberg, Rockhampton and Mackay in Central Queensland. From south to north each of these is approximately 400 kms or half a day's drive from the other. The university also has campuses for international students in four east coast major cities. It specialises in multi-modal flexible delivery offering many of its courses to students from any location nationally and internationally. The majority of students studying the BMS are actually in this flexible mode category. When they come to study the capstone, two-terms long, Collaborative Multimedia Project course they are expected to work in teams on authentic projects for real clients. Some team members do not meet each other, their supervisor, or their client face to face. They are charged with project planning and production using virtual communication modes under a rigorous program of learning and assessment (Holmes, Kinslow, & Pope, 2010). The objective is to provide students with authentic experience that matches the prescription of Herrington et al (2003):

- Provide 'authentic contexts' that reflect the way the knowledge will be used in real life
- Provide 'authentic activities'
- Provide access to 'expert performances' and the modelling of processes
- Provide 'multiple roles and perspectives'
- Support 'collaborative construction of knowledge'
- Promote 'reflection' to enable abstractions to be formed
- Promote 'articulation' to enable tacit knowledge to be made explicit
- Provide 'coaching' and 'scaffolding' by the teacher at critical times
- Provide for 'authentic assessment' of learning within the tasks.

An objective is to provide student individuals with authentic, collaborative, work integrated learning experiences that reflect the predominantly team-based nature of contemporary creative digital production industry in Australia (Barrett, 2001; Higgs, Cunningham, & Pagan, 2007; Noacco, 1995). As highlighted in Holmes, Kinslow & Pope (2010), the problem is not so much managing the student teams through this journey, but rather, sourcing sufficient projects of appropriate level of challenge, on a regular basis for the 60 or so students who undertake the course annually. Thus, when the opportunity with QAL arose it was immediately recognised as a potential win-win scenario.

Outcomes

The ultimate outcome was not one interactive multimedia-training manual, but two. The first, developed and produced during the period March to October 2008 concerned general safety induction, foundation training manuals and Pump

Overhaul and Maintenance Procedures (POMP) for the Elliot Turbine and Gearbox. The student team consisted of five members; from Townsville and Mackay in Queensland, from Lismore in New South Wales, from Dubai and from Taiwan. The second, developed and produced during the period March to October 2009 documented procedures relating to assembly and overhaul of two slurry pumps: the Worthington 12LN32 and the Warman 8/6 FAN. This training manual also incorporated quizzes to test knowledge transfer and comprehension. For this project there were six team members, somewhat less widely dispersed in that they were all from Queensland, with four based in Bundaberg, one in Rockhampton and one in Brisbane.

Guided by online course instructions and resources, in each case students organised themselves into roles and nominated a single point of contact for client and supervisor liaison. At the outset they negotiated a team agreement that included a conflict resolution strategy. Then they consulted with the client to perform needs analysis and project definition. They produced a design brief, developed the concept, undertook project planning and the established of procedures for production management and quality control. In the second part of the course each team produced and presented Alpha and Beta prototypes for evaluation and testing before presenting the final product for acceptance. The supervisor performed a trial audit during the production phase to determine whether and how effectively the project and quality management procedures they had established earlier were being followed.

Each team had unique project obstacles to overcome. The 2008 team had to produce audiovisual recordings of expert demonstrations. In 2009 these were provided but in raw unprocessed format to be edited. While the first team had no design precedent to follow the second did, but opted to redesign the information hierarchy and aspects of the interface to enable easier navigation. Each team worked with a variety of media, repurposing technical diagrams, procedural documents and photographs. One team detected flaws in documentation that had occurred at a much earlier stage when the QAL had first begun digitising its technical data, and which had gone unnoticed in the company's knowledge management procedures. In each case the product met the client's acceptance criteria. The tangible outcomes were usable manuals for pump maintenance trainees that incorporated demonstrations of critical procedures by experts and technical and procedural documentation.

In each case there were less tangible benefits too. For example, the client's retiring experts felt satisfied that they would leave a worthwhile legacy for trainees to come. The contracting students who had been able to visit the site had experienced firsthand an industrial environment quite alien to them and been subjected to workplace health and safety induction and other procedural rigor. One or two expressed that the way they were expected to apply their digital production skills was quite mundane compared to their coursework experiences and this had come as a surprise to them. Their expectations for creative opportunity did not match the actuality.

SECI analysis of the outcomes

Analysis of the outcomes from a knowledge conversion perspective using Nonaka's SECI model is quite revealing. From the client's perspective the expert tacit knowledge has through collaborative socialisation been externalised and through a process of combination synthesised into a communication of value to the

organisation. From the perspective of each individual on the student contractor team, the explicit knowledge gained in their formal coursework has been converted into knowledge more universally applicable through collaborative socialisation and through the opportunity to experience a more tacit dimension in a manner that they could sensibly internalise. As Nonaka and von Krogh (2009) point out, outcomes such as these can be understood in terms of knowledge conversion and in terms of social practice. The ultimate knowledge creation outcome for the organisations involved is “product and process innovation”. Each individual involved achieves enhanced personal understanding. Teams come to greater collective understanding and all have advanced capacity to act.

The broad trends for knowledge conversion for both parties in this work integrated learning collaboration can be appreciated as being reciprocal and complementary. The temporal nature of the project development practice meant that there were numerous iterations of cycles of explicit and/or tacit problem solving along the way.

Invocation of Pink’s conceptual age “senses”

Using Daniel Pink’s (2006) ‘conceptual age’ criteria to analyse the process and outcome of this inter-organisational collaboration, it can be said that the design of the interactive training manuals synthesised a symphony of technical and process oriented data with stories from senior personnel that playfully infused the instructional narratives with empathy, thus creating more meaningful transfer of organisational knowledge critical to the safe maintenance of plant at the QAL facility. Interestingly, from the point of view of the multimedia education specialist, this is an advantage that multimedia teams are well placed to offer, given that they often comprise both creative production and information communication technology practitioners (artists and geeks) thus potentially providing expertise more suited to a holistic approach to communication problem solving.

Evidence from literature

Efficacy of knowledge conversion using stories

Some few texts that claim that the use of stories in the context of knowledge transfer is an effective way to bring out and share the deep smarts. Leipold and Voelpel (2006) claim that, along with document mining and knowledge mapping, story telling is considered “an effective enabling mirror to employees” for the purpose of knowledge capture and transfer. They say that one of the major values of stories is their ability to convey knowledge that “cannot be represented as explicit propositions or rules” and that stories can effectively transmit the explicit ‘how’ along with tacit reflective values. Leipold and Voelpel (2006) warn that whilst “stories are a critical building block for the transfer and retention of the most critical and valuable knowledge in organisations” ... “the idea of intentionally pursuing them as a knowledge transfer tactic is sometimes regarded with suspicion or doubt, because stories violate Western business norms that value analysis over narrative”. Meanwhile Patton (2002) cites Shaw et al (1998) claiming, “cognitive scientists have found that stories are more memorable and better support learning than nonstory narratives”.

Efficacy of knowledge conversion using video and digital media

In the contemporary, digital video and information communication technologies are the most cost effective means of recording, storing, accessing and distributing stories for the purpose of knowledge transfer. Yet there seems little hard evidence for the efficacy of knowledge transfer using digital video incorporated as part of an integral instructional training package. Much of the literature predates the ubiquity of digital video as we know it and references to videorecording earlier than 2000 are likely to be referring to stand-alone videotape console delivery. Even though hypertextual multimedia was existent from the early 1990s video was not widely produced or disseminated via this means because of storage media and hardware performance limitations and the comparative expense of production. Recall that CD ROM drives did not become commonplace until around 1997 and DVD video was initially released in Australia in 1999. Digital video streaming via the Internet had to wait for the right combination of hardware, software, protocols, standards and bandwidth availability before it could become the everyday actuality most of us experience today. Founded in 2005, *YouTube* has raised both the expectations for and acceptance of the tiny screen as a ‘proper’ medium.

Pea (2006) describes the development of a project called *Digital Interactive Video Exploration and Reflection (DIVER)* at Stanford University. He advocates the somewhat futuristic system designed to enable “user-driven content re-use, prompted by the desire of content users to reinterpret content in new ways, and to communicate and share their interpretations with others, for purposes ranging from e-learning to entertainment.” The treatise contains significant reviews of relevant literature, yet Pea (2006) insists that,

...there is substantial need, for research in the learning sciences, for e-learning purposes, and for facilitating collaborative work both in face-to-face teams and at a distance, for new methods that foster capturing, navigating, analyzing, re-purposing, and commenting on video as a medium for representing situated practices (p. 1326).

Asserting that expertise is a demonstration of the application of knowledge, Dalkir (2005) says that “[a]lthough we cannot observe someone’s knowledge we can observe and identify expertise. The key is to use audio or video to record what the expert knows.” He adds, “experience has shown that video recordings of informal and unrehearsed demonstrations form a permanent record of task knowledge—one that can be mined repeatedly” (p. 90). In presenting a number of case studies De Long (2002) observes that videotaped interviews can be one of the most expensive methods of capturing knowledge. He advises that “[o]rganizations using interviews to transfer knowledge need to think through the process that will be used to integrate the knowledge captured into the organization” (p. 4).

Hawamdeh and Refai (2008) make the claim, quite unsubstantiated in their review of the literature, that “[v]ideo and audiovisual materials are considered to be the most effective medium for capturing tacit knowledge in the absence of real-world interaction and networking” (p. 235).

Clementina and Capra (2008) outline a project, in a workplace context similarly hazardous to the environment at QAL, the purpose of which was to make tacit knowledge of workplace health and safety within in a shipyard explicit and usable. The authors claim that by collecting audiovisual evidence of good practices and adapting them to on-the-job-training modules “it was possible to considerably

decrease work-related casualties and to improve work conditions and occupational health.” However no data is presented in the cited paper to qualify or quantify this claim. The authors conclude that “[m]otivation of workers, as well as their active participation to learning, were the two most important issues to be addressed.” A number of papers talk to the matter of engagement using multimedia in specific learning contexts (McNamara, & Shapiro, 2005; Grissom, McNally, & Naps, 2005) and using specific combinations of media (Chapman, Selvarajah, & Webster, 1999).

An interesting case study where a multimedia teaching environment was constructed using situated learning principles and its efficacy surveyed (Herrington, & Oliver, 2000) also contains a useful reference list citing similar studies. In their analysis the use of the multimedia application in that specific context they report that one of the most useful aspects was the facilitation of collaboration—in its own right and “as a vehicle for operationalisation of other elements of the model.”

There is a celebrated, long-running debate between two authors who have conducted longitudinal meta analysis of research about whether or not particular media influence learning; Richard Clark and Robert Kozma. The debate is chronicled in Clark (2001). Essentially Clark argues that “media are mere vehicles” and that there are no learning benefits to be gained employing any specific medium. He points to evidence of “confounding” in media research due to uncontrolled methods and what he calls “content effects” including the novelty of new media. The criticism encompasses research into computer-based instruction. Clark (2001) says, “In confounded research causes and effects cannot be unambiguously identified” (pp. 1-18). He concludes that learning from instruction is a complicated process that involves “interactions between specific tasks, particular learning traits and various components of medium and method” (p. 39). Kozma’s (1991, 1994) contrary argument is that certain media “possess particular characteristics that make them more or less suitable for certain tasks.” He asks, “In what ways can we use the capabilities of media to influence learning for particular students, tasks and situations?” After Salomon (1974, 1979) Kozma (1991) argues for media to be considered as symbol systems, for example, video can be thought of as a medium capable of employing representational (that is pictorial) and audio-linguistic symbol systems—among others. In 1979, when summarising the general premise on which his arguments are based Salomon wrote, “... for the two ‘systems’, media and cognition, symbol systems serve as the most essential attribute; therefore their interrelations need to be explored” (p. 216).

That mental symbolic representation as imagined by Salomon is necessary for cognition is a foundation of cognitive psychology. A counter cognitive theory, arguably more consistent with Polanyi’s notion of tacit knowledge is that of embodied cognition. According to Merleau-Ponty (1962) and other phenomenologists (Polanyi, 1966, 1999; Noë, 2004) there is no mind-body separation or duality; indeed cognition is experienced as a bodily function conditioned by presence and intention in time and situated in the environment. As Polanyi (1966) wrote, “Our body is the ultimate instrument of all external knowledge” (p. 15).

In 2006 Massey & Montoya-Weiss published a paper that “draws from and extends Nonaka’s (1994) theory of knowledge creation.” Significantly it is cited in Nonaka and von Krogh (2009). In the context of the afore-going discussion this article has considerable relevance because the authors present a model for media selection and

use with respect to knowledge conversion. Their extension to the theory involves new premises including: a greater emphasis on the temporal nature of the knowledge conversion process; a topology of media use that recognises two distinct phases—“monophasic” and “polyphasic”; a concept of media expansion that incorporates the cyclic nature and fluctuations that occur in knowledge conversion and creation; metrics to include “perceived media utility” factors such as richness, social presence, and interactivity. Term monophasic simply refers to when participants use one media at a time and polyphasic to where participants deploy multiple media simultaneously. Whilst due recognition is given in the model to individual learning and media use styles or preferences the authors postulate that “a polyphasic temporal structure will accelerate the acquisition of various individual and joint experiences in the knowledge conversion process” (p. 11). Such conjecture would be unlikely to hold sway with an empiricist such as Richard Clark (2001)! But perhaps this model could provide a basis for future further interpretive analysis of the development and deployment of interactive multimedia training modules from a knowledge conversion perspective?

Clearly, what this precursory review of the literature reveals is that there is a need and plenty of scope to apply quantitative and qualitative method in the further search for answers on the question of the efficacy of story narratives and their recording, storage and utilisation in preservation and transfer of industry critical information, especially as part of an interactive multimedia training program.

Conclusion

The two product outcomes that were the subject of the inter-organisational case study section of this paper achieved the objectives set for them from the point-of-view of the client and the point-of-view of the contractor. The client gained multimedia artefacts that contribute to the intergenerational transfer of knowledge for the pump maintenance crewmembers. In particular the technical and cognitive dimensions of the tacit knowledge and wisdom of retiring engineers was made more explicit and combined with existing information for the benefit of less experienced workers thus extending the overall value and accessibility of the total knowledge in that area of the organisation. In a hazardous processing environment the effective transfer of this knowledge is particularly critical for occupational health and safety as well as for the uninterrupted safe and productive operation of the plant. The contractor achieved the objective of providing student individuals with authentic, collaborative, work integrated learning experiences that reflect the predominantly team-based nature of contemporary creative digital production industry in Australia. The inter- and intra-organisational learning was as valuable as the experience all individuals involved gained. One possibility for further research would be to follow up and interview the graduates to gain reflective insight into the impact the course experience may have had on their vocational development.

Given that, in the context of this discussion paper, no substantive empirical claims about the efficacy of knowledge transfer using recorded stories as part of digital media training aids can be made (beyond the functionality testing and evaluation that the student teams undertook during the production of the case study artefacts), and that the review of literature has revealed no consensus on the matter, this is obviously a field of research in need of attention. In the light of Pink’s assertions regarding the attributes required for a new conceptual era it is likely that the understanding yielded would benefit not only those engaged in vocational and

tertiary fields of education, such as the parties involved in the case study presented in this paper, but also the community at large.

Acknowledgements

Writing this paper would not have been possible without the collaboration of Ruth Kinslow, formerly Business Improvement Coach at QAL and Michael Pope from the Pump Maintenance crew at QAL. The supportive interest and mentorship of Patrick Keleher, Coordinator of the Work Integrated Learning Special Interest Group of the Learning Education and Teaching Research Centre at CQUniversity is also acknowledged.

References

- Barrett, R. (2001). Labouring under an illusion? The labour process of software development in the Australian information industry. *New Technology, Work and Employment*, 16, 18-34.
- Chapman, P., Selvarajah, S., & Webster, J. (1999). Engagement in multimedia training systems. In *System Sciences, 1999. HICSS-32. Proceedings of the 32nd Annual Hawaii International Conference*.
- Clark, R. E. (2001). *Learning from media: Arguments, analysis and evidence*. Greenwich, Connecticut: Information Age Publishing.
- Clementina, M., & Capra, E. (2008). Tacit knowledge, learning experiences, scaffoldings and wireless connections: How work contexts can influence workers' informal learning and suitable technologies can enhance learning organisations. In proceedings, *Designing eStrategies for Learning Organisations*, ElfEL (European Institute for E-Learning). Retrieved December 3, 2010, from http://www.eife-l.org/publications/proceedings/ilf08/contributions/designing-estrategies-for-learning-organisations/clementina_capra.pdf.
- Dalkir, K. (2005). *Knowledge management in theory and practice*. Butterworth-Heinemann.
- De Long, D.W. (2004). *Lost knowledge: Confronting the threat of an aging workforce*. Oxford: Oxford University Press.
- De Long, D. W. (2002). *Better practices for retaining organizational knowledge: Lessons from the leading edge*. Research report for Accenture, Institute for Strategic Change. Retrieved December 3, 2010 from <http://www.accenture.com/isc>.
- Grissom, S., McNally, M. F. & Naps, T. (2003). Algorithm visualization in CS education: comparing levels of student engagement. *SoftVis '03 Proceedings of the 2003 ACM symposium on software visualization*.
- Gourlay, S. (2006). Conceptualising knowledge creation: A critique of Nonaka's theory. *Journal of Management Studies*, 24(7), 1415-36.
- Haukka, S. (2010). From education to work in Australia's Creative Digital Industries: Comparing the opinions and practices of employers and aspiring

creatives. *60Sox Report 2*, Creative Workforce Program, ARC Centre of Excellence for Creative Industries and Innovation.

Hawamdeh, S., & Refai, H. (2008). Video management and the transfer of knowledge through audiovisual material. In T. Srikantaiah, & M. E. D. Koenig (Eds.), *Knowledge management in practice: Connections and context* (pp. 223-38), American Society for Information Science and Technology.

Herrington, J., Oliver, R., & Reeves, T. (2003). Patterns of engagement in authentic online learning environments. *Australian Journal of Educational Technology*, 19(1), 59-71.

Herrington, J., & Oliver, R. (2000). An instructional design framework for authentic learning environments. *Educational Technology Research and Development*, 48(3), 23-48.

Higgs, P. L., Cunningham, S., & Pagan, J. D. (2007). *Australia's creative economy: Basic evidence on size, growth, income and employment*. Technical Report, Faculty Research Office, CCI. Retrieved December 3, 2010, from <http://eprints.qut.edu.au/8241/1/8241.pdf>.

Hislop, D. (2009). *Knowledge management in organisations: A critical introduction*. Oxford: Oxford University Press

Holmes, A., Kinslow, R. & Pope, M. (2010). Learning integrated work: Inter-organisation collaborators reflect on providing an authentic learning experience for multimedia project teams. Unpublished.

Kearsley, G. & Schneiderman G. (1998). Engagement theory: A framework for technology-based teaching and learning. *Educational Technology*, 38 (5), 20-24.

Keleher, P., Patil, A., & Harreveld, B. (2011). *Introduction to work integrated learning in engineering, built environment and technology: Diversity of practice in practice*. IGI Publishers.

Leipold, M., & Voelpel, S. (2006). *Managing the aging workforce: Challenges and solutions*. New York: Wiley.

Leonard, D. & Swap, W. (2005). *Deep smarts: How to cultivate and transfer enduring business wisdom*. Harvard University: Harvard Business School Press.

Linde, C. (2001). Narrative and social tacit knowledge. *Journal of Knowledge Management*, 5(2), 160-70.

Kozma, R. B. (1994). The influence of media on learning: The debate continues. *School Library Media Research*, 22 (4), 1994.

Kozma, R. B. (1991). Learning with media. *Review of Educational Research* 61, 179-211.

McNamara, D. S., & Shapiro, A. M. (2005). Multimedia and hypermedia solutions for promoting metacognitive engagement, coherence and learning. *Journal of Educational Computing Research*, 33(1), 1-29.

- Maturana, H., & Varela, F. (1987). *The tree of knowledge: The biological roots of human understanding*. Boston: New Science Library.
- Massey, A. P., Montoya-Weiss, M. M. (2006). Unravelling the temporal fabric of knowledge conversion: A model of media selection and use. *MIS Quarterly*, 30(1), 99-114.
- Merleau-Ponty, M. (1962) *Phenomenology of perception*. Smith, C (tr.) London: Routledge & Kegan Paul. [Orig Pub 1945].
- Noacco, D. J., (1995). Multimedia markets: A study of Australian content developers. *Australian Journal of Educational Technology*, 11(2), 52-74. AJET 11.
- Noë, A. (2004). *Action in perception*. MIT Press.
- Nonaka, I., & von Krogh, G. (2009). Tacit knowledge and knowledge conversion: Controversy and advancement in organizational knowledge creation theory. *Organization Science*, 20(3), 635-52.
- Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science*, 5(1) 14–37.
- Patton M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed). Thousand Oaks, CA: Sage.
- Pea, R. (2006). Video-as-data and digital video manipulation techniques for transforming learning sciences research, education, and other cultural practices. In J. Weiss et al. (Eds.), *The international handbook of virtual learning environments* (pp. 1321-93). Springer.
- Pink, D, H. (2006). *A whole new mind: Why right-brainers will rule the future*. New York: Riverhead Books.
- Polanyi, M. (1969). On body and mind. *New Scholasticism*, 43(2), 195-204.
- Polanyi, M. (1966). *The tacit dimension*. New York: Doubleday & Co.
- QAL (2010). Retrieved December 2, 2010, from http://www.qal.com.au/About_Overview.html.
- Salomon, G. (1979). *Interaction of media, cognition, and learning*. San Francisco: Jossey-Bass.
- Salomon, G. (1974). What is learned and how it is taught: The interaction between media, message, task, and learner. In D. Olson (Ed.), *Media and symbols: The forms of expression, communication, and education*. Chicago: University of Chicago Press.
- Shaw, G., Brown, R., & Bromiley, P. (1998). Strategic stories: How 3M is rewriting business planning. *Harvard Business Review*, 76, 41-50.