Unknown knowns; uncovering tacit knowledge for the design of interactive media

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Unknown knowns; uncovering tacit knowledge for the design of interactive media

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Abstract: In my research I am exploring the potential role of the designer as a mediator between cultural heritage, as represented by traditional craft makers, and people today who are interested in understanding and employing these skills. In this paper I shall discuss design strategies for using multimedia to record traditional craft skills in the form of a learning resource which would offer the opportunity for new makers to draw upon the skills of experienced craft practitioners whilst directing their own learning at a pace and style that suits their craft practice.

Keywords: tacit knowledge, multimedia design, educational multimedia, video ethnography, lo-fi prototyping.

Introduction

"... as we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns - the ones we don't know we don't know."

Donald Rumsfeld, United States Secretary of Defense, 2003.

For experienced craft practitioners much of their practical knowledge resides within the body; actions are tacit responses to complex combinations of cues, instinctive responses to their senses. My earlier research[1] considered methods for designing multimedia to support learning of such tacit knowledge. It indicated that many craft practitioners had difficulty communicating practical knowledge and were uncomfortable with learners' innovation. In current research I am considering designers' strategies for eliciting practical craft knowledge using video recordings and interviews to promote cycles of reflection and analysis, allowing practitioner and observer to interpret techniques and recognise variations. In each cycle of the research the developing learning resource has been a tool for recording and evaluating what has been discovered so far and investigating deeper layers of the problem.

[1] Wood N (2003). *Design for tacit learning.* Proceedings of EAD conference, Barcelona, April 2003.

Tacit knowledge

Much of a craft practitioners' practical knowledge is deeply internalised; through frequent repetition they have come to respond instinctively to a complex combination of cues. In every-day practice this is of little importance, but it does become significant if they wish to explain what they are doing either to a novice practitioner or to a designer like myself who wishes to record the skill. Traditionally, craft teaching took place through the apprenticeship system where the practitioner would demonstrate, the learner observe and imitate, and the teacher correct until the learner gained a sufficient degree of proficiency to work unaided.

This teaching process has been described as "making the tacit knowledge explicit", maybe from misinterpretation of the work of Nonaka & Takeuchi[2] whose book popularised the concept of tacit knowledge within knowledge management. My experience leads me to agree with Rust[3] that this view is misguided. In reality the tacit knowledge remains tacit, the personal property of the practitioner or "personal knowledge" as Polanyi[4] originally called it. Explicit knowledge is used to articulate the tacit, perhaps verbally through metaphors, analogies etc. or, as frequently observed in the craft context, visually through demonstration, sketching or modelling. Gamble[5] gives a vivid description of such interaction from her observation of cabinet making apprentices at a trade school in South Africa: "When asked in an interview about the propensity to draw everything, an apprentice called drawing his 'third language' (in addition to two spoken languages)." Through this process learners are able to construct *their own* version of the tacit knowledge as they repeatedly perform the skill.

In earlier research I observed experienced craft practitioners teaching and used the findings[1] to propose a framework for the design of multimedia to support learning of tacit knowledge. I also observed the difficulty even experienced teachers had finding ways of expressing their practical knowledge, and this formed the focus of this stage of the research alongside the further development and testing of the framework.

Rather than producing a prescriptive, step-by-step approach to learning a skill, the aim of the resource is to make clear the vital elements and to leave the remainder in a format more open to exploration and personal interpretation. Much neglected by educational theory is the second phase of the traditional learning process, the journeyman. Upon completion of the apprenticeship, novice practitioners would travel and work with other masters of their trade to broaden their knowledge and skills outside the scope of the master they trained with. It was only upon successful completion of their journey and acceptance of their masterpiece by their trade guild that they could become a master in their own right[6]. Achievement of this phase is vital both for the development of the

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[2] Nonaka I and Takeuchi H (1995). *The knowledge-creating company: how Japanese companies create the dynamics of innovation.* Pub Oxford University Press, New York.

[3] Rust C (2004, in press). *Design Enquiry: tacit knowledge and invention in science.* Design Issues 20, November 2004.

[4] Polanyi M (1958). *Personal knowledge; towards a post-critical philosophy.* Pub Routledge & Kegan Paul, London.

[5] Gamble J (2002). *Teaching without words: tacit knowledge in apprenticeship.* Journal of education 28 pp63-82.

[6] Epstein, S R (2004). *The generation and transmission of technical knowledge in pre-modern Europe, c.1200-c.1800.* Proceedings of the Global Economic History Network annual conference, Leiden, The Netherlands available at http://www.lse.ac.uk/collections/economicHistory/GEHN/GEHN%20Conference%204%20Papers.htm.

learner, ceasing to become imitative of their master and developing their own style, and for the craft as a whole if it is to continue to develop and evolve.

Methodology

This paper represents interim findings, half way through a 3 year course of research. To pretend I have a resolved methodology at this stage I feel would be neither truthful nor helpful. From my research into design methodology I have come to believe this is not the way designers work, or the way to progress design research. As cognitive scientist Henrik Gedenryd comments in his thesis *How Designers Work*[7], "Experience from design practice and from studies of authentic design processes has consistently been that not only don't designers work as design methodology says they should, it is also a well established fact that to do design in the prescribed manner *just doesn't work*" (author's original italics). Upon completion of this research I would hope to trace a path back through this work and then be able to present a methodology which would be of use to other designers undertaking such work. In the mean time, I offer some work-in-progress in the belief that such sharing helps all of us actively involved in design research advance and improve our work.

So far my methodology has primarily been based upon techniques used in the fields of knowledge management and cognitive task analysis, which are effectively summarised by Edwards[8] in what he calls stages of knowledge engineering:

> *"Acquisition* consists of acquiring or eliciting the basic knowledge.
> *Representation* involves organising and structuring the knowledge.
> *Execution* is putting the knowledge into a machine-executable format"

Although, for the last phase, I am putting the knowledge more into a "learner-executable" format as in Randel *et al*[9] where they call the three phases: knowledge elicitation, knowledge representation and use in training.

My approach differs from these because the procedures described above take a systems approach, seeking to record and systemise processes and the knowledge behind them to create a computer programme, either to replicate the process or to train somebody in the replication of the process. In the context I am working, exact reproduction of the process is neither possible nor desirable due to the tacit nature of the skills involved and the hand-crafted nature of the products. Instead I have taken a strongly ethnographic approach, choosing to work in far greater depth with just one practitioner (*Figure 1*) and three learners for this part of the research.

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[7] Gedenryd H (1998). *How Designers Work.* PhD thesis, Lund University Cognitive Studies 75, Sweden.

[8] Edwards JS (2003). *Knowledge Engineering: A Forgotten Element in Knowledge Management*. Keynote Presentation to OR Society Annual Conference 2/3 September 2003 available at http://www.orsoc.org.uk/conf/previous/or45/OR45%20Knowledge%20Engineering.doc

[9] Randel J M, Pugh L H and Wyman B G (1996). *Methods for Conducting Cognitive Task Analysis for a Decision Making Task.* Navy Personnel Research and Development Center.

Figure 1 Craft practitioner: traditional bowl turner, Robin Wood.

To consider in greater detail the acquisition, representation and execution stages:

Acquisition

A variety of different techniques have been developed and tested in the field of cognitive task analysis for eliciting practical knowledge. Cooke[10] provided a basis for considering these, and concurrent verbalisation and stimulated recall were selected as most appropriate. This stage is described in detail in another paper[11] but in summary, concurrent verbalisation yielded only the procedural knowledge which could easily be articulated whilst the craft practitioner worked, although this was useful in its own right to help initially structure the learning resource. Stimulated recall, where normal practice was videoed and immediately afterwards practitioner and observer watched the video together, provided a platform for more in-depth discussion of the practice.

These two sessions provided a depth of understanding into one particular instance of the practice, but what I also felt was needed was a breadth of understanding across several incidences of the practice. To achieve this I performed "successive observation" where normal practice was videoed over a series of days, and then the videos were compared for similarities and differences. At this point I became aware there might be differences between the practitioner's perception of his practice and his actual practice, as well as areas where my understanding was incomplete. The final part of this stage was a semi-structured ethnographic interview[12] to draw the practitioner into talking about the issues raised by the elicitation/observation process.

Representation

My representation of the knowledge elicited took the form of a learning resource based on the framework developed during my previous research but, to maximise flexibility during the early part of the process, I adopted a "lo-fi" approach[13]. To begin with, the "resource" consisted of a few hand-written notes and drawings supported by some short video clips taken from the elicitation/observation stage which were on a laptop computer

[10] Cooke N J (1994). *Varieties of Knowledge Elicitation Techniques.* International Journal of Human-Computer Studies vol 41, pp 810-849.

[11] Wood N (2004). *Unknown knowns: knowledge elicitation for multimedia in craft learning.* Proceedings of Challenging Craft conference, Robert Gordon University, Aberdeen, October 2004.

[12] Wood L E (1997). *Semi-Structured Interviewing for User-Centred Design*. Interactions, volume iv, no 2, pp48-59.

[13] Rettig M (1994). *Prototyping for tiny fingers.* Communications of the ACM, vol 37, no 4, pp 21-27.

to enable use in the workshop. By testing this with users (see “execution”, below) I was able to prioritise the material, seek out and explore difficulties and develop it into a more formal, paper-based resource with more focussed video clips (*Figure 2*).

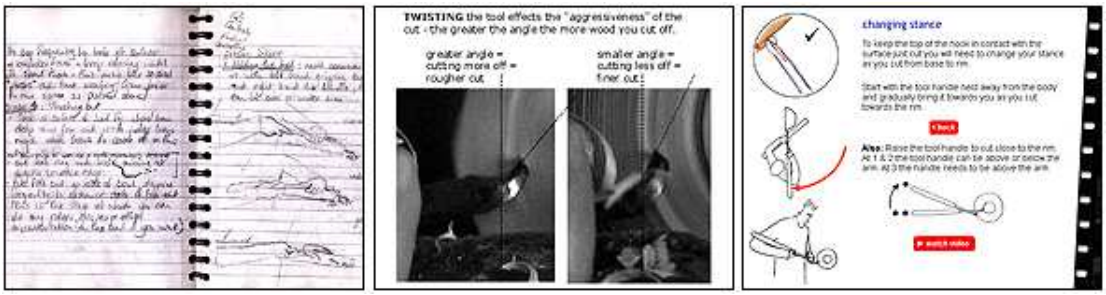

Figure 2 Examples from three phases of the learning resource.

To begin with, when there was a higher degree of explicit knowledge to be conveyed, the availability of still images and printed material was at its most important to the learners. They watched video of the practitioner closely, but were unable to retain the information and translate it into their own actions. I was struck at this stage by current debate in the press about a series of photographs showing abuse of prisoners in Iraq. David Modell[14], photographer and documentary filmmaker, effectively summarised it: "Moving images can never be this potent. We cannot retain and carry with us a video-clip in the same way." This was also borne out by research into the value of different forms of graphical representation in educational multimedia. In both their own experiments and a review of others’ similar work, Narayanan and Hegarty[15] found little evidence of animation being more effective than printed material.

Watching the learners using the resource, I could see that both animated and printed materials were necessary as they addressed the different phases of learning I had identified as necessary for tacit learning in previous research (*Figure 3*). Watching the video of the practitioner at work provided the learner with an overview of what they were trying to achieve, addressing the cognitive level, but they also needed the printed material to address the associative level and provide an aide-memoir in the workshop.

Whilst developing the printed material, the learners expressed a preference for drawings over photographs: one commenting they were much simpler to interpret, another finding difficulty adjusting the photographs taken from an observer’s perspective to her own perspective. As Barbara Tversky[16] points out "drawings reveal people's conceptions of things, not their perceptions of things" and I found I could use drawings to represent what was necessary, from the learner’s perspective, and with no extraneous detail.

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[14] Modell D (2004). *Viewpoint: power of abuse pictures.* Story from BBC news http://news.bbc.co.uk/go/pr/fr/-/1/hi/world/americas/3710617.stm

[15] Narayanan NH and Hegarty M (2002). *Multimedia design for communication of dynamic information.* International Journal of Human-Computer Studies, vol 57, no 4, pp 279-315.

[16] Tversky B (1999). *What does drawing reveal about thinking?* In JS Gero and B Tversky (eds) "Visual and spatial reasoning in design", Key Centre of Design Computing and Cognition, Sydney, Australia, pp 93-101.

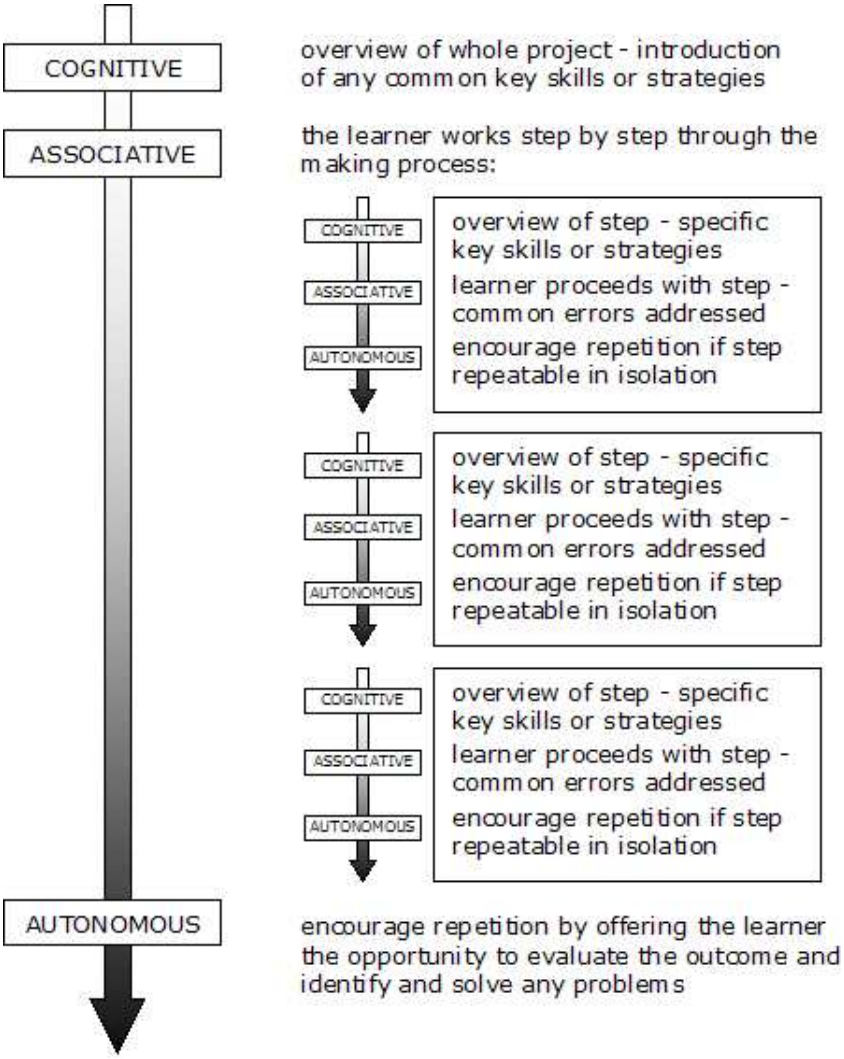

Figure 3 Learning resource framework showing phases of learning.

Execution

As it developed, the lo-fi prototype resource was tested with learners (*Figure 4*), both to check the veracity of the knowledge elicited and my representation of it. To aid understanding of the subtleties of this learning process, I have chosen at this stage to work closely with a small number of learners, allowing deep understanding and easy communication between us. The first test involved just one learner, the second used learner one again plus learner two, and the third used these two learners again plus a third.

As well as allowing easy revision of the material, this prototype also provided an environment in which the learners as well as the designer could be involved with its

development. In much the same way as Ehn and Kyng[17] used their “cardboard computer” to enable print workers to imagine using a computer that had not yet been built, my note book and video clips allowed both myself and learners to imagine how the learning resource might work. By playing the role of interface between the learner and the material, I was able to involve responses from the learners and adapt the material I had dynamically during sessions to maximise their impact.

Figure 4 Learners in the workshop.

In addition, the process allowed the craft practitioner to reflect upon his own practice and revealed some significant differences between his assumed and his actual practice. I had suspected these differences when comparing the successive observation videos to the practitioner’s description of his work during interview. During my first session with a learner I encouraged him to experiment with both the practitioner’s stated method and the observed method, and he favoured the observed method. When we reached the limit of my knowledge, at which the learner could no longer progress, we invited the practitioner into the workshop to teach directly. After briefly watching the learner, the practitioner’s first action was to try to correct him on this issue, so I intervened to explain that the learner’s actions were based on observation of the practitioner. He very strongly denied this and challenged me to prove it, so I showed him the material the learner had been using, which greatly surprised him. Once this “unknown known” had been realised, it allowed a greater understanding of this part of the process and the craft practitioner became increasingly open-minded about both his perceptions of his own practice and learners’ experimentation.

Use of a video camera to record the proceedings allowed me also to play the role of passive observer by taking a record that I could watch after the event. As with my previous research, these recordings were not treated as hard data to be chunked, coded and analysed, but used as an enriched record of that stage of the design process[18]. Much of what was recorded was highly visual in nature and its significance only began to emerge as the process progressed and *my* tacit knowledge increased.

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[17] Ehn P and Kyng M (1991). *Cardboard Computers: mocking-it-up or hands-on the future.* In Greenbaum J and Kyng M (eds) ‘Design at Work: Cooperative Design of Computer Systems’, pub Lawrence Erlbaum, Hilldale NJ, pp 169-195.

[18] Buur J, Bindar T and Brandt E (2000). *Taking Video beyond 'hard data' in user centred design.* Proceedings of the Participation and Design Conference (PDC 2000), New York available at http://www.sdu.dk/Nat/MCI/UCD/PUBLICATIONS.HTM

Conclusion

So far this approach has provided an effective way of capturing, structuring and delivering the rich depth of knowledge involved in craft skills. In particular, the lo-fi prototype of the learning resource has proved capable of much more than just testing usability, but has also allowed the craft practitioner to reflect upon the tacit knowledge employed in his practice, the designer to reflect on her understanding of the practice and her representation of it, and the learners to test the veracity of all three.

This prototype has now served its purpose and I am currently revising the material and building an interface for it using Macromedia Director software. Upon completion, I plan to put this through more rigorous testing with learners with further modification where necessary. Alongside this, the generalisability of these findings needs testing and I am currently planning to undertake further studies with different craft practitioners.

It is also hoped that, as the testing continues and some of the learners' skills become more developed, it will be possible to observe and refine design for the journeyman phase. By the time learners achieve this level of competence, it is hoped the tacit knowledge will need virtually no explicit knowledge to articulate it and learners will be able to draw what they need just from video. This then also offers the opportunity to include in the resource video of diverse other practitioners of the craft, allowing the learner to pursue their "journey" from their own workshop.