December 1997

Expert Commentary on Videoed Expertise (EXCOVE): An approach to knowledge elicitation in little-understood, complex domains

Phillip Carter
Massey University

Jon Patrick
Massey University

EXpert Commentary on Videoed Expertise (EXCOVE): An approach to knowledge elicitation in little-understood, complex domains

Philip Carter
Department of Information Systems
Massey University
Private Bag 102904
North Shore, New Zealand
P.Carter@massey.ac.nz

Prof. Jon Patrick
Department of Information Systems
Massey University
Private Bag 11222
Palmerston North, New Zealand
J.D.Patrick@massey.ac.nz

Keywords: knowledge elicitation, knowledge acquisition, complex domains, accessing tacit knowledge, video recording

Abstract
Knowledge elicitation (KE) is the initial stage of acquiring knowledge of a domain from domain experts. KE needs to be independent of the field of expert systems so that it can be applied to other endeavours in information systems and to highly complex and little understood domains ('open' domains). EXpert Commentary of Videotaped Expertise (EXCOVE) is an approach to KE developed as a response to the needs of psychotherapy research for astute observation and careful description and from a deficiency of suitable KE methods. The collection of expert commentary on specific videoed-taped expert-executed events is the core of EXCOVE. This strategy aims to retain the advantages of open questioning, minimise the possibility of copious, unwieldly and inaccurate data, and trigger and bring to consciousness the viewing expert's cognitive processes. Data has been collected in the domain of psychodrama, a group psychotherapy, using EXCOVE and a range of analyses from theory validation to theory construction have been done. Results indicate that EXCOVE generates useful and rich data on 'open' domains.

Psychotherapy is where a therapist and client(s) work together for some desirable change in the psychological or social functioning of the client(s). Psychotherapy research is primarily concerned with investigating what helps people to change. A major criticism of psychotherapy research is the lack of astute observation and careful description (Burlingame, Kircher and Taylor, 1994).

EXpert Commentary of Videotaped Expertise (EXCOVE) was developed as one response to the challenges facing psychotherapy research and is designed to maximise the richness and quality of observation and description. For psychotherapy, EXCOVE involves the capture on videotape of therapy sessions lead by highly experienced and regarded practitioners with subsequent expert commentary on the content of the videos. The use of multiple experts and video recordings have been little recognised or utilised in psychotherapy research.

From an information system's perspective, EXCOVE is an approach to KE. It is novel in its use of expert commentary and video recordings and its applicability to 'open' domains. This paper frames EXCOVE by discussing KE, its scope, and the nature of expertise and implications for KE. The core components of EXCOVE; expert commentary and video recording are then described.

Knowledge elicitation

KE is the gathering of information from sources of expertise and is the initial phase of knowledge acquisition (KA) (Brule & Blount, 1989; Cooke, 1994; Cooke & McDonald, 1988; Wood & Ford, 1993). Other phases in KA include one or more of analysis, interpretation, representation, and modelling (Belkin, Brooks & Daniels, 1987; Kemp, Todd, Silva & Gray, 1994; Kidd, 1987; Wielinga, Schreiber & Breuker, 1991).

While KE is critical to the quality and success of KA, little attention has been given to KE (Hart, 1992; Hoffman, 1992). Regoczei and Plantinga (1988) think that this lack of attention could be because KE is perceived as being much harder to deal with. There is little consensus on methodology (Gruber, 1989) and very little systematic understanding of how best to do KE (Wood & Ford, 1993) with most research and practise being based on a 'patchwork' of methods and techniques imported from other disciplines (Gaines, Shaw & Woodward, 1993). Cumulative knowledge about KE is also severely hampered by the lack of informative details about methods used during KE sessions (Hoffman, 1992). The process of KE needs to be made explicit and different methods need to be investigated and documented.

The scope of KE

In computing, KA has been considered part of the field of expert systems where the aim is to automate or partially automate some activity of human expertise. However, KE and KA cannot be constrained within the field of expert systems, even when the scope of expert systems is expanded out of a strict artificial intelligence and automation framework (Regoczei, 1992). KA is increasingly important for a range of other computing endeavours; for example, tutoring systems and adaptive interfaces (Cooke, 1994) and tools for social science research (Heather & Lee, 1995). Systems analysis can also be considered to involve a large amount of KA if the system user can be perceived as an expert informant for a particular situation (Kemp, 1996; Regoczei & Plantinga, 1988). Independence of KA from expert systems is also suggested by important commentators within the field of KA. They see the elicitation and representation of knowledge using the techniques of KA, independent of whether an expert system is created, as helping people to create new understandings and capabilities (Clancey, 1993), as worthwhile (Hoffman, 1992), and a grand, new enterprise (Regoczei, 1992). This is supported by Ford and Bradshaw's (1993) finding that often the most important product of expert system projects is the insight gained from KA rather than the knowledge-based system.

One of the consequences of confining KA within expert systems, is that development and study of KE techniques have focused on well-structured domains (Belkin, Brooks & Daniels, 1987; Ericsson & Simon, 1993). However, the vast majority of real world problems are ill-defined which Reitman (1964) describes as when one or more of the initial state, transitions, or final states are unclear and/or when there is no systematic way to tell whether the solution is correct.

Researchers in expert systems have realised the brittleness and limited nature of their successes, but have been unable to build a functional expert system for a general task domain. Obstacles are complexity (Ericsson & Simon, 1993), the common sense problem (Lenat, 1986), and the dynamic, changing nature of the world (Clancey, 1993). However, rather than building expert systems that simulate all the functioning of an expert, there is increasing realisation of the usefulness of augmenting human capabilities in collaborative systems (Clancey, 1993). Here the general strategy is to divide the work so the person and the machine each do what they are good at (Gruber, 1989). Clancey's (1993) vision is that such expert systems will collaborate with social scientists providing them with flexible prototyping tools for adjusting to change and tools that will facilitate not just automate conversations. Such tools have already appeared in social science research to assist theory development and qualitative data research, and provide advice and instruction (Heather & Lee, 1995). Such approaches mean expert systems can be developed in more complex, general task domains. Appropriate KE and KA techniques for these complex domains will be required.

Information Systems, too, is increasingly concerned with the study of 'open' domains. Holistic real-world answers are needed to real-world problems (Rouse & Dick, 1994), which includes the study of human-to-human and human-to-technology behaviour within an organisation (Parker, Wafula, Swatman & Swatman, 1994). However, there is a scarcity of published material on research methodologies for 'open' domains, especially qualitative methods, and software tools to support such efforts (Rouse & Dick, 1994). Rouse and Dick (1994) found that most case studies go directly from a discussion of the sampled population to the research findings without any description of how the pages of notes and interview reports were reduced and interpreted and with little reference as to how such analysis might be enhanced by computer support.

In summary, in the field of computing KA needs to be independent of the narrow confines of expert systems. There is a need to develop KE and KA methodologies for complex domains for a range of computing endeavours. This is more so as computing moves out of relatively well-structured concerns such as word processing, spreadsheets, and business databases, and into more complex arenas such as, education, psychology, and linguistics. Prior to 1987, there were few studies of KA in complex domains (Belkin et al., 1987). Since then, some studies have emerged (Kemp et al., 1994). The development and investigation of EXCOVE as a method of KE for 'open' domains aims to assist in this investigation.

The nature of expertise

An important question for KE is whether an expert's knowledge is tacit, and if it is, how much is tacit. Anderson's (1983) distinction between static, *declarative* knowledge about facts and *procedural* knowledge which is knowledge about *how* to perform cognitive activities is accepted by many in cognitive psychology (Gordon, 1992). While declarative knowledge is verbalisable, much of our skilled behaviour is driven by procedural knowledge that is not verbalisable. Studies in cognition show procedural knowledge for a task becomes highly automated over time so that processing requires little conscious cognitive resources and is unavailable to conscious awareness (see Gordon (1992) for a summary). As procedures become automated, the ability to verbalise the knowledge decreases.

The years of learning and experience it takes to become an expert, suggests experts' procedural knowledge is tacit (Brule & Blount, 1989; Gruber, 1989). In an early but influential paper, Nisbett and Wilson (1977) propose that there is little or no direct introspective access to an expert's cognitive processes. They found that verbal reporting is based on *a priori*, causal judgements of plausibility which are sometimes accurate, sometimes not. This has support from studies that show reconstructed reasoning, of the kind that forms the basis of most major textbooks, is inaccurate (Musen, 1993).

Does this mean that an expert's knowledge is not available to introspection and their verbal reports can not be accurate or complete? Fortunately, studies since Nisbett and Wilson have identified factors that affect consistency and accuracy of expert's verbal reports. The type of questioning has an important impact on the ability to access tacit knowledge. There is evidence that concurrent (occurring at the time of the task being done), 'think aloud' verbal reports give richer data about the cognitive processes the reporter is going through than do interviews and post-event questioning (see Ericsson and Simon (1993) for a summary). Think aloud reports where the expert just verbalises the thoughts they are thinking has shown greater accuracy than ad-hoc justification and explanation (Ericsson & Simon, 1993).

Ericsson and Simon (1993) reason that subjects verbalise thoughts in response to specific cues in attention and perception which is supported by Ford *et al.*(1993) and Cooke and McDonald (1988). Kagan and Kagan (1991) in their process of Interpersonal Recall find the use of video playback greatly enhances viewers ability to access cognitive processes occurring in the original event. These studies suggest that what is in, and available to, consciousness is influenced by contextual factors; the closer the context of the recall, the greater the access and accuracy.

Another potential factor that impacts on the ability to self report is an expert's degree of consciousness about competence. There has been little recognition of the possibility of varying degrees of consciousness. An exception is Regoczei (1992) who states that the ability of an expert to verbalise and communicate his knowledge seems connected with whether the expert has a conceptual model of the knowledge. Reason (1994) explicitly addresses this possibility believing that experts can be trained to be more conscious. He found that although initially there is often a loss of performance, this can be re-established.

In summary, providing rich context and targeting experts with conscious competence maximises the possibility of an expert's accessing their knowledge accurately and comprehensively. EXCOVE uses some of the principles outlined above in its use of expert commentators and video recordings.

Expert commentary
In the initial phase of KE, it is claimed that the expert should be encouraged to talk freely (Wood & Ford, 1993) and in a natural way (Gruber, 1989; Hart, 1992). While a concurrent, think aloud method encourages this and is good for accessing tacit knowledge as previously discussed, it cannot be used when the task of itself involves verbal communication or already has high cognitive demands (Cooke, 1994), or when reasons and explanations of the expert's actions are sought. This is the case in many tasks and certainly in psychotherapy. In these cases unstructured interviews using an open questioning style are usually considered the best way to achieve the initial data gathering aims and is the most common technique used (Cooke, 1994).

Scott, Clayton and Gibson (1991) classify questions on a spectrum from highly open to very closed where the most open question might begin; "Tell me about...". Gorden (1975) gives 5 dimensions of scope for questions and also gives, "Tell me about..." as an example of the beginning of the broadest question.

Open questions have many advantages over more closed or specific questions. The way in which a question is phrased has a demonstrable effect on the answer which is given (Brule & Blount, 1989; LaFrance, 1987). Open questions can minimise the possibilities of leading questions and introducing bias (Pidgeon, Turner & Blockley, 1991).

Open questions are used to get certain types of information that can be distorted using specific questions. This includes unanticipated information, an expert's path of association, the relative importance of various aspects, the frame of reference, the chronological order, and the vocabulary (Gorden, 1975). These sorts of information are needed in the initial phase of KE, especially when the domain is not well understood and is complex as in psychotherapy.

Open questions also have important motivational effects (Gorden, 1975) in establishing rapport between the knowledge engineer and the expert (Cooke, 1994) and involving the expert in the process so that they become committed to it (Pidgeon et al., 1991). The dangers of the knowledge engineer interrupting (Hart, 1992; Wood & Ford, 1993) or dominating (Pidgeon et al., 1991; Wood & Ford, 1993) are also minimised.

However, the usual way of using open questioning in an unstructured interview comes at a large cost: copious, unwieldly data that can be irrelevant and incomplete (Cooke, 1994). This results not from open questions, but from the lack of focus on specific instances which causes vagueness, digression, repetition, and information difficult to analyse (Hart, 1992). Specific instances cue and activate an expert's processing mechanisms (Regoczei, 1992) and details of operation (Brule & Blount, 1989) because knowledge becomes structured only in response to some specific problem to be solved or set of complex information to be acted upon (Bellezza, 1992).

A profitable approach would therefore be one that combines open questioning with a focus on specific instances thereby retaining the multiple advantages of open questioning, minimising the possibility of unwieldy and irrelevant information, and activating the appropriate cognitive processes. Such an approach appears to have received relatively little attention. Wood and Ford (1993) suggest the use of examples with open questions but do not list this approach in their table of question types (Table I, p. 78). (Cooke, 1994) lists various types of techniques that focus on specific cases but does not explicitly link open questions with them. And Cordingley (1989) describes retrospective case description, indirect questions (open), and the use of video recording, but does not combine them to be a significant KE approach.

EXCOVE takes this approach of combining open questions with focus on specific events (realised through the use of video-recordings) and calls it commentary. Multiple experts comment on a video-recording of an event. Commentators are of two types, those who participated in the event and those who didn't. Both types of commentators are given broad and general guidelines for giving their comments on the videotaped event. Commentary is recorded on audiotape that facilitates the commentators expression in a free and natural way (Hart, 1992).

The use of teacher or trainer experts in the field as commentators is not explicitly specified in EXCOVE although it is potentially very useful. As previously discussed, experts are most likely to have varying degrees of consciousness about their competence. Teachers will have already made the effort to understand and communicate their knowledge. Ericsson and Simon (1993) and Scott *et al.* (1991) express support for the use of teachers especially in the early stages of KE. However Ericsson & Simon (1993) relate studies that show the correlation between expert competency and ability to teach related skills is low and the cognitive processes mediating expert performance may be quite different from the steps given by teachers to novices. Further studies are required for clarity on this matter.

Video recordings

There are few reported cases of the use of video recordings in KE and of these the majority are for recording interviews with experts (Scott et al., 1991) rather than recording performance, although Cordingley (1989) describes video recording both at the same time. A study by Belkin *et al.* (1987) demonstrates the advantages of recording expertise for use in KE. The expert is audio recorded at work on real problems in her normal environment with subsequent interviews greatly enhanced by having the recorded data at hand. Although the recording is audio, the same procedure can be used with video. The strong advantages video offers KE, especially for expertise that has a visual component, have been virtually ignored. The advantages of video for KE are: sensory-rich memory cues; control over viewing; enhanced awareness; convenience; non-evasive; and usefulness in analysis. Each of these is discussed below.

- *Sensory-rich memory cues.* Concurrent reporting is considered powerful because subjects verbalise thoughts entering attention in response to specific cues in attention and perception. Whereas, post-event recall is relatively inaccurate and weak because of the deficiency of specific cues. Studies by Tulving (1983) show the ability to recall a past event depends on compatibility between the trace (memory about the event) and the cue (information at the time of retrieval). Video increases this compatibility by providing cues rich in visual and auditory information. Use of video minimises memory retrieval errors and assists reconstructions (Cooke, 1994) and recall.
- *Control over viewing.* Another key advantage of video recording is control over viewing. Video gives the expert commentator the abilities to both slow the viewing process down (Kagan & Kagan, 1991) through pause and, for multiple viewing using rewind. Pausing and rewinding fosters detailed examination of events that occur in human interactions that are too numerous to consciously attend to in real time.
- *Enhanced awareness.* Kagan and Kagan's (1991) found that when participants viewed video replay of their previous inter-personal activities, they were conscious of things they were not normally aware of that, such as other people's subtle emotions. Kagan and Kagan believe one reason for this is that during video replay viewers are not so caught up emotionally as they are during the real event. Further research is needed to explore whether video replay provides a greater ability to attend to and be aware of thoughts compared with the *in vivo* situation.
- *Convenience.* Video captures the event for viewing at convenience. This is especially useful when the number of viewers is large and multiple viewings are necessary.
- *Non-evasive.* Video can be useful when direct observation will interfere with performance (Brule & Blount, 1989; Cooke, 1994). However, the extent to which video interferes with performance is not known. The presence of cameras and the thought of being latter evaluated could have strong effect on participants' performance.
- *Useful in analysis.* Video data can also be valuable in later stages of analysis. It can be used in a variety of ways such as, confirmation and validation of models against the data, and in developing consensual rating schemes.

Although none of the elements of EXCOVE's approach are new (video and commentary), the combination appears to be novel. It is not suggested by Wood and Ford (1993) or Cordingley (1989) and it fails to fit easily into any of the categories given by Cooke (1994) in her comprehensive coverage of KE methods from the fields of psychology, business management, education, counselling, cognitive science, linguistics, philosophy, knowledge engineering and anthropology.

Success of the mechanisms in EXCOVE will have some implications for the question of whether KA is a transfer, extraction, or mining activity rather than a co-construction activity between the expert and the knowledge engineer (the researcher working with the expert). Current beliefs are that KA is more a co-construction activity (Boose & Gaines, 1988; Cooke, 1994; Ford et al. 1993). Possible reasons for this are:

1. The influence of the knowledge engineer's attitude and relationship with the expert on the knowledge produced.
2. The possible lack of correspondence between verbal comments of an expert with what actually happened (Kidd, 1987).
3. The possible inferiority of the expert's model and the improvement that the knowledge engineer can make.
4. The necessity for the knowledge engineer to interpret (Kidd, 1987) and re-conceptualise the knowledge so that it can be computerised (Wielinga et al., 1991).

If the mechanisms in EXCOVE are successful, the effects of 1 to 3 will be minimised and so KE using EXCOVE will be more a mining activity. However, once post-KE stages of KA are undertaken, the knowledge engineer will play an increasing role in interpretation and what to focus on in analysis and so the activity will become more co-construction. EXCOVE indicates that KA can be both mining and co-construction and that they are complimentary rather than mutually exclusive.

Evaluation

EXCOVE has been applied in psychodrama research, a type of group psychotherapy. Three psychodrama sessions of about three hours duration each were video recorded. In total there were ten separate psychodramas lead by four different expert psychodrama directors. For each psychodrama, commentaries on the video-recorded psychodramas were collected from the director and from three other expert practitioners who were not originally present. Commentators were asked to comment on the important things going on for the director and the group, the core psychodrama principles, and anything interesting. They were asked to imagine they were talking to a naive audience.

A computer system, FERAL (Flexible Environment for Research And Learning), was specifically developed to organise the data and to provide facilities for analyses. FERAL provides synchronisation of video and text data, encoding with multiple, concurrent, and independent code sets, memoing and annotating, and a range of analysis facilities.

A range of analyses were done on the collected data, including theory and data driven approaches which both involved a range of theory validation, refinement, and construction tasks. In the theory-driven approach, three processes identified as important in the literature were investigated. There were several instances of these processes in the video recordings and a wealth of descriptive information in the commentaries on these instances. Multiple commentaries enabled comparative analyses where both consensus and divergence were important and the video recording provided much contextual and behavioural data. A number of difficulties with previous descriptions of the processes were identified, clarifications and discoveries were made, and further questions raised. In the data-driven approach, several processes and concepts were investigated using the commentary and video data and some initial hypotheses were made. Further data and more detailed commentary were identified as necessary next steps.

Despite the divergent analysis approaches, a basic analysis method using the EXCOVE data evolved. The core of this is:

1. Get all commentary concerning a concept.
2. Browse existing memos and gather any relevant information.

For each comment do steps 3 to 5:

3. Summarise the information.
4. View the segment of the video the comment refers to and describe any relevant behaviour.
5. Add in any comments from other commentaries for the same time period.
6. Analyse the information in table with the aim of formulating an initial descriptive language of the concept. Convergence and divergence are both useful.
7. Look for previously un-commentated on occurrences of the phenomena (concepts and/or behaviour) described in the descriptive language in the commentaries, and if the phenomena are observable, in the video data too. Refine the description language based on the new occurrences if need be. Repeat this step until no further refinement occurs.

The usefulness of the analysis depends on how representative the data is and the conceptual clarity of the commentators. Identifying and involving experts and assessing when the collected data is representative enough are therefore important tasks.

Conclusions

KE is an important and useful endeavour in itself independent of whether an expert system is developed. Video replay shows real promise as a mechanism for assisting experts to access their tacit

knowledge. Detailed studies are needed to investigate this in detail. Analyses done using data collected using an EXCOVE approach in psychodrama indicate that it is productive in investigating psychotherapy process and suggest an EXCOVE approach could be useful for other 'open' domains.

References

Belkin, H. J., Brooks, H. M., & Daniels, P. J. (1987). Knowledge elicitation using discourse analysis. *International Journal of Man-Machine Studies, 27*, 127-144.

Bellezza, F. S. (1992). Mnemonics and expert knowledge: Mental cuing. In R. R. Hoffman (Ed.), *The psychology of expertise: Cognitive research and empirical AI*, (pp. 204-217). New York: Springer-Verlag.

Boose, J. H., & Gaines, B. R. (Eds.). (1988). *Knowledge acquisition tools for expert systems*. London: Academic Press.

Brule, J. F., & Blount, A. (1989). *Knowledge acquisition*. New York: McGraw-Hill.

Clancey, W. J. (1993). The Knowledge Level Reinterpreted: Modeling Socio-Technical Systems. In K. M. Ford & J. M. Bradshaw (Eds.), *Knowledge Acquisition as Modeling*. New York: John Wiley & Sons.

Cooke, N. J. (1994). Varieties of knowledge elicitation techniques. *International Journal of Human-Computer Studies, 41*, 801-849.

Cooke, N. M., & McDonald, J. E. (1988). The application of psychological scaling techniques to knowledge elicitation for knowledge-based systems. In J. H. Boose & B. R. Gaines (Eds.), Knowledge acquisition tools for expert systems, (pp. 65-82). London: Academic Press.

Cordingley, E. S. (1989). Knowledge elicitation techniques for knowledge-based systems. In D. Diaper (Ed.), *Knowledge elicitation principles, techniques and applications*, (pp. 89-173). Chichester: Ellis Horwood.

Ericsson, K. A., & Simon, H. A. (1993). *Protocol analysis: Verbal reports as data*, revised edition. Cambridge, Mass: MIT Press.

Ford, K. M. & Bradshaw, J. M. (1993). Introduction: Knowledge Acquisition as Modeling. In K. M. Ford & J. M. Bradshaw (Eds.), *Knowledge Acquisition as Modeling* (pp. 1-7). New York: John Wiley & Sons.

Ford, K. M., Bradshaw, J. M., Adams-Webber, J. R., & Agnew, N. M. (1993). Knowledge Acquisition as a Constructive Modeling Activity. In K. M. Ford & J. M. Bradshaw (Eds.), *Knowledge Acquisition as Modeling*, (pp. 9-32). New York: John Wiley & Sons.

Gaines, B. R., Shaw, M. L. G., & Woodward, J. B. (1993). Modeling as framework for knowledge acquisition methodologies and tools. *International Journal of Intelligent Systems, 8*, 155-168.

Gorden, R. L. (1975). *Interviewing: Strategy, techniques, and tactics*. Homewood, Ill: Dorsey.

Gruber, T. R. (1989). *The acquisition of strategic knowledge*. Boston: Academic Press.

Hart, A. (1992). *Knowledge Acquisition for expert systems*. New York: McGraw-Hill.

Heather, N., & Lee, R. M. (1995). Expert systems for the social scientist. In R. M. Lee (Ed.), *Information technology for the social scientist*, (pp. 169-188). London: UCL Press.

Hoffman, R. R. (1992). Doing psychology in an AI context: A personal perspective and introduction to this volume. In R. R. Hoffman (Ed.), *The psychology of expertise: Cognitive research and empirical AI*, (pp. 3-11). New York: Springer-Verlag.

Kagan, N. (1975). Influencing human behavior: Eleven years with IPR. *Canadian Counselor, 9*, 44-51.

Kagan, N. I., & Kagan, H. (1991). Interpersonal Process Recall. In P. W. Dowrick (Ed.), *Practical guide to using video in the behavioral sciences*. New York: John Wiley & Sons.

Kemp, E. A. (1996,). *The role of the individual project in teaching knowledge acquisition*. Paper presented at the Internation Conference on Softwar Engineering, Education, and Practice, Dunedin, NZ.

Kemp, E. A., Todd, E. G., Silva, A. d., & Gray, D. I. (1994,). *Knowledge acquisition applied to farmer decision making*. Paper presented at the Second Singapore International Conference on Intelligent Systems, Singapore.

Kidd, A. L. (1987). Knowledge acquisition: An introductory framework. In A. L. Kidd (Ed.), *Knowledge acquisition by analysis of verbatim protocols*, (pp. 1-15). New York: Plenum Press.

LaFrance, M. (1987). The knowledge acquisition grid: a method for training knowledge engineers. *International Journal of Man-Machine Studies, 26*, 245-255.

Musen, M. A. (1993). An overview of knowledge acquisition. In J. M. David, J. P. Krivine, & R. Simmins (Eds.), *Second generation expert systems*. Berlin: Springer-Verlag.

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review, 84*(3), 231-259.

Parker, C. M., Wafula, E. N., Swatman, P. M. C., & Swatman, P. A. (1994,). *Information systems research methods: The technology transfer problem*. Paper presented at the Fifth Australasian Conference on Information Systems, Melbourne.

Pidgeon, H. F., Turner, B. A., & Blockley, D. I. (1991). The use of grounded theory for conceptual analysis in knowledge elicitation. *International Journal of Man-Machine Studies, 35*, 151-173.

Reason, P. (1994). Three approaches to participative inquiry. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research*, (pp. 324-339). London: SAGE.

Regoczei, S. (1992). The psychology of expertise and knowledge and acquisition: Comments on the chapters in this volume. In R. R. Hoffman (Ed.), *The psychology of expertise: Cognitive research and empirical AI*, (pp. 297-313). New York: Springer-Verlag.

Regoczei, S., & Plantinga, E. P. O. (1988). Creating the domain of discourse: ontology and inventory. In J. H. Boose & B. R. Gaines (Eds.), *Knowledge acquistion tools for expert systems*, (pp. 293-308). London: Academic Press.

Reitman, W. R. (1964). Heuristic decision procedures, open constraints, and the structure of ill-defined problems. In M. W. Shelley & G. L. Bryan (Eds.), *Human judgments and optimality*. New York: Wiley.

Rouse, A., & Dick, M. (1994,). *The use of computerized tools in qualitative information systems studies*. Paper presented at the Fifth Australasian Conference on Information Systems, Melbourne.

Scott, A. C., Clayton, J. E., & Gibson, E. L. (1991). *A Practical Guide to Knowledge Acquisition*. Reading, Mass: Addison-Wesley.

Tulving, E. (1983). *Elements of episodic memory*. New York: Oxford University Press.

Wielinga, B. J., Schreiber, A. T., & Breuker, J. A. (1991). *KADS: A modelling approach to knowledge engineering* : University of Amsterdam.

Wood, L. E., & Ford, J. M. (1993). Structuring interviews with experts during knowledge elicitation. *International Journal of Intelligent Systems, 8*, 71-91.