

They do admit that “term interviewing can intimidate an expert”, but hold that “the gain in accuracy and amount of information obtained from using this technique usually outweighs any side effects”.

The advice in this first section seems to be very much based on their particular experience and philosophy. Looked upon in this light it is quite worth reading. They cover all the important aspects of what you need to know before embarking on the development of a knowledge-based system. For a beginner however, the distinction between personal opinion, generally agreed procedure and hard facts may be difficult to identify.

I did find the development section rather more clear cut. They describe variations on the prototyping approach and give examples of appropriate situations for each. Their testing and evaluation chapter is particularly well presented and I was glad to see a chapter on project scheduling.

The knowledge representation section is mainly a catalogue of the methodologies for recording expert knowledge and strategies for its use. I did not find these examples helpful or practical, but perhaps I am suffering from the cultural difference between Europe and the author's Stateside experience.

So to whom is this text most appropriate? Should a beginner ever try to get to grips with the art, or science, of knowledge engineering from a book? I will side-step that question and say that in any case this would not be the book for that task. It could make interesting reading for knowledge-based systems practitioners who wish to broaden their point of view perhaps. The one category of reader to whom I can be certain in recommending this book is the apprentice knowledge crafters of Messers Walters and Nielsen's own team. These eager young workers are, they insist, an essential ingredient in every knowledge crafting team to ensure the future expansion of knowledge-based systems.

Knowledge engineering for expert systems by M Greenwell, Ellis Horwood, Chichester, pp 184, £25.00, ISBN 0 7458 0513 2.

Knowledge engineering by TB Cross, Brady, New York, pp 266, \$34.95/£30.40, ISBN 0 13 516741 8.

“Knowledge engineering”: it would seem reasonable to suppose the term has been used long enough for us to have arrived at a stable consensus about its meaning, without allowing it to diffuse into the lay world in a fuzzy state and suffer the increasingly-inevitable debasement. Indeed, in the glossary at the end of each of these recent books are to be found similar definitions: for Greenwell, “the process of building expert systems including identification, feasibility, knowledge acquisition, knowledge analysis, implementation, delivery and maintenance”; for Cross, just “the process of building expert systems”. That, however, is about the only common ground, besides a single reference (the perennial 1983 book edited by Hayes-Roth, Waterman and Lenat, “Building Expert Systems”) that the authors share. The major part of this review will therefore involve separate discussion of each work, before returning briefly to the meaning of the subject they share.

Mike Greenwell's book appeared in July 1988. Had it been a few months earlier, it would certainly have been cited in this author's recent review of knowledge acquisition (Neale, 1988), for it fills a gap in the market. The audience comprizes knowledge engineers, expert system project managers and potential experts. Greenwell's background is in cognitive psychology; he has been involved in knowledge engineering since at least 1985. His primary concern is the lack of an integrated methodology for building expert systems, and in outlining what should be done he concentrates on perhaps the most problematic area, knowledge acquisition (which subsumes knowledge elicitation). This is where knowledge engineering differs most from conventional systems analysis, because in addition to the external requirements for the system (what the user wants) there is the much harder task of identifying and modelling the expert's personal problem-solving knowledge (“perhaps” is used advisedly above, because although this is very much the conventional wisdom and not hard to justify, there is a case to be made for the most difficult phase of expert system building being validation and testing).

The great virtue of this book is the wealth of succinct and sound practical advice on how to go about building an expert system. Based very largely on the author's own experience, but avoiding an overly prescriptive approach (which techniques the knowledge engineer chooses to employ are a matter of personal choice, he says), the book provides several useful check-lists of questions to ask, plus bullet-point summaries at the end of each chapter. The discussion of knowledge elicitation methods concentrates (appropriately) on interviewing and largely eschews the more esoteric psychological techniques. There are perhaps one or two other works which might lay claim to similar ground; Greenwell goes further, however, and includes the even more difficult area of how to *analyse* the knowledge. Knowledge engineers inclined to the conceptual modelling approach to knowledge acquisition—as distinct from the more ad hoc direct-implementation route implicit in rapid prototyping—will particularly welcome this discussion.

The book is structured as eleven chapters followed by a glossary, a partially-annotated bibliography, and an index. An adequate introduction is followed by a brief foray into the contentious area of the nature and different forms of expertise; the chief benefit (for the reader who has not thought about this already) is the delimitation of the kind which might be susceptible to modelling for an expert system. The next short chapter, headed “Knowledge elicitation as a social situation”, is important for the distinctions it makes from systems analysis. That this should appear early in the book is appropriate and necessary given the technology-led approach which (at least in this author's opinion) still dominates the field. The fourth chapter should really be on the feasibility study, which instead is left to chapter nine; in this should be included the user analysis which Greenwell tacks on to a general discussion of interviewing in this chapter. In chapter five interviewing is covered in detail, followed by other techniques for knowledge elicitation. The author then proceeds to set out what should be covered in “The first interview” (in fact the first two or three, in most instances), before covering in chapter seven “Planning and preparation”: this again seems illogical sequencing and would be better placed earlier, after the feasibility study. Knowledge analysis, the subject of chapter eight is, whilst welcome, rather selective in what it includes and not as satisfactory as it could have been. After the misplaced analysis of the feasibility study which follows, the author presents his views on project management. The final chapter is a case study of the Alvey EMEX project on econometric modelling: this is quite thorough and particularly helpful in view of the general paucity of reporting on knowledge acquisition in the public domain.

The reader may conclude from the last few pages that the author became rather pressed for time. The glossary is very selective in covering only twenty-one terms. The same number of references is cited, with author's annotations for some; the last eight appear as a separate alphabetically-ordered block. The index, however, is concise, nearly complete, and easily read. About sixty-seven typographical errors (admittedly mostly minor, but including twice mis-spelling the name of a former collaborator!) suggest the proof-reading was rushed.

As a whole, the book is well-written and aside from the sequencing of certain chapters, clearly set out. A lot of material is covered in a space short enough to be readily accessible for its target readership. It is, on the other hand, undeniably a personal book with fewer references in the text to the reported insights and experience of other practitioners than this reviewer would have liked. Greenwell also deliberately confines discussion of computer aids to knowledge acquisition to half a page: whilst nothing he says here is actually untrue, it is misleadingly superficial and does not help the reader to anticipate the future of the art. The other principal area worthy of expansion, as suggested earlier, is knowledge analysis. For example, there is no mention of decision trees, although several less familiar diagramming techniques such as epistemic nets and augmented transition networks are discussed. The KADS methodology, subject of a large and fundamentally important European ESPRIT project, is included, although the author confusingly uses the central idea of the interpretation model in two different ways (pp 112 and 171)—which he admits. In fairness, however, the theoretical nature of KADS deliverables to date is hard to explain in a short space and Greenwell does a good job otherwise on this topic.

In summary, Mike Greenwell has contributed a valuable account of how knowledge acquisition may be approached in a structured manner, with appropriate stress on documentation. Anyone who

is not already sure they know how it should be done, or committed to a particular computer-based approach, will be rewarded by reading this book.

And now for something completely different. Thomas Cross contradicts his succinct and recognizable glossary definition by describing knowledge engineering on page 2 as “the application of machine systems to problems of human endeavor”. That really does set the tone of the book: whereas Greenwell’s book is about “how to do it”, Cross discusses knowledge engineering (stretching the term for a moment) at a strategic level. Indeed, the book would have been far more appropriately titled something like “Communicating with computers: implications for management information strategies”. No doubt someone suggested a sexier title was needed.

The book is “for those who are faced with management problems of all kinds and would like to think there may be some emerging technologies that can help solve them. Most importantly, for those managers who realize that communication is the most significant part of any working activity” (preface). The author’s background is primarily in telecommunications, especially teleconferencing. His knowledge of expert systems and AI would appear to be the product of “five years research”, up to possibly mid-1986, but there is no evidence that Cross has any personal experience of building a knowledge-based system (as the term is commonly understood).

The principal merit of this book is twofold: it is very forward-looking and offers a view of integrated knowledge technology which is quite exciting and convincing, despite having apparently been about two years in press. The first chapter, entitled “Trends in knowledge engineering” is possibly the best and worth reading by the knowledge engineer who wonders what he or she might be doing in five years time. It is no bad thing for anyone who is closely interfaced to a computer to periodically step back and visualize the wider picture. The reader nonetheless does need to have some intuitive feeling for management (American management in particular), in order to maintain momentum—and a high tolerance for fashionable two-letter acronyms which litter the book. Beware, on this point, that “TP” is variously used for “text processing” or “thought processing”! (pp 164/179).

The second chapter, on “Issues in knowledge engineering”, is short and weak except for the final page on the essential topic of “understanding”. Chapter three is about expert systems; a lengthy, rambling exploration with which at many points this reviewer was at odds. Cross makes no mention of non-monotonic systems, or machine learning in general (barring a short and vague discussion in a later chapter). Statements like “Expert systems are no panacea for programming” (p 78) and “Problems are solved [by humans] at random in spite of all attempts to bring rules and procedures into play” (p 79) (what about case-based reasoning?) are scattered around. A completely nonsensical statement of Godel’s theorem is quoted. The whole chapter of forty-two pages is “summarized” in just seven lines. Not a helpful account.

There is a brief interlude about “Visualization systems” (inevitably, “VS”) before we are plunged back into “Artificial intelligence”, which the author had earlier made a confused attempt to distinguish from expert systems. Ten of the fourteen quotations in this chapter are from books published over twenty years ago. Again, seven lines (the magical number?) are offered in a hopelessly inadequate “summary” of the chapter.

The reader’s confidence makes a cautious comeback in the following substantial account of knowledge networking systems, as this is clearly the author’s subject. It is unfortunate, though, that Cross does not mention the Colab project developed at Xerox PARC over the past four years, as this arguably represents the state of the art in LAN computer support for meetings.

There follows a short account of some “real world” applications of knowledge engineering systems, which in keeping with the rest of the book is mostly too general, abstract and even conjectural to be of much use. Only on pages 177–8 does the reader (for the first time in the book) briefly encounter some ideas about how knowledge engineering (as it is usually understood) is done. A final chapter on “Future trends in knowledge engineering” includes a reference to “Developments in distant places such as Viewdata developed by British Telecom” (p 199)—yes, in the early 1980s!

The glossary is good, although in view of the traditional definition offered of knowledge engineering, the reader may wonder whether the author was personally responsible for it. The

bibliography includes 184 references up to April 1985, which are in addition to others quoted in the text; 44 are by T.B. Cross, 17 of these being apparently unpublished presentation addresses. An additional feature is a listing of AI resources, principally but not entirely tool vendors; the single non-US source is the Turing Institute, of "Glasgow, Ireland" (p 247). The index is quite satisfactory. The general standard of production is excellent (only 6 typographical errors).

This book may be of interest to management information systems strategists (primarily for its discussion of knowledge networking), but this reviewer cannot recommend it as worthwhile serious reading for knowledge engineers. The argument is not with the idea that future strategic issues of information technology and computer communications are irrelevant. Current awareness in this fast-changing world is vital, of course. The problem is that Cross does not appear to be either sufficiently accurate, precise or up to date in his information, in areas familiar to knowledge engineers, to engender the reader's confidence to persevere through the jumbled structure of the book. There are far too many statements lacking in meaning to allow the reviewer to recommend more than perhaps scanning a library copy.

These two books in fact tackle "knowledge engineering" from radically opposing perspectives. Greenwell is concerned with the actual practicalities involved in the earlier stages of building expert systems. Cross takes a strategic view of a much broader area, from a height at which Greenwell's subject is scarcely visible as a distinct issue. This is very much a superset of that defined in the glossary, whereas Greenwell confines his attention to a subset of his definition of knowledge engineering. Greenwell deals with a small, well-bounded area and does it well; Cross attempts a large, ill-defined domain with less successful results. The fact that the latter chooses to write about a much broader interpretation of the term "knowledge engineering" than that which is conventionally held should not be taken as a criticism in itself, however. It does raise the valid point of whether confining the term to the building of expert systems is still appropriate; particularly now it is increasingly recognized that this is one of a family of related and in practice integrated technologies. Even more closely should we consider whether "knowledge engineering" ever has been a suitable appellation for the art of knowledge acquisition. The reviewer is inclined to propose that one who is "skilled in knowledge" should be described as a knowledgician, just as a logician is skilled in logic.

References

- Neale, IM, 1988. "First generation expert systems: a review of knowledge acquisition methodologies", *Knowledge Engineering Review* 3(2) 105-145.

What every engineer should know about artificial intelligence by William A Taylor, MIT Press, 1988, pp 331, £19.95.

I found the title of the book very attractive and I really wanted to know what was it that every engineer should know about Artificial Intelligence (AI). The book begins by giving some reasons why engineers should consider AI, but not a lot of the rest of the book is specific to engineering. In fact it can be read profitably by anyone who wants to gain an overview of AI and access the relevance of the technology but is not interested in reading very technical material. The book is written in a style that is very easy to read and it does not assume much computing background from the readers.

The author presents a very practical view of AI. He writes, "For engineering purposes artificial intelligence is a few software ideas that work well enough for commercial use". The few software ideas include different programming styles, languages, and advanced programming environments that stemmed from AI research. The author does not advocate a particular style or language. His own view is that "I have been in engineering long enough to know that no single tool, no matter how wonderful, can perform *all* jobs well. I am happy to adopt ideas from logic programming or object-