use and development of knowledge-based systems to help meet Australia's growing need to compete in world markets. The facts and arguments in support of these recommendations will also inform a far broader, world-wide readership of professionals, industrialists, educators, scholars and government officials about these knowledge-based systems. It will help them identify opportunities to use them successfully and to take account of pitfalls and critical success factors.

The report accomplishes this purpose with exemplary brevity, clarity and simplicity. Knowledge-based systems are computer programs that store knowledge in a special, well-defined area of expertise and are capable of making certain kinds of inferences from proposition in this store as well as from their users. Some systems are capable of improving their performance through use by correction of errors, by being informed about actual outcomes of actions they recommend and by continual updating and refinement of their knowledge bases. The intended user of one expert system used as an illustration, FIRES, is a ranger in a national park concerned about the nature of fires that might break out in his region. Doctors, nurses and patients illustrate users of three levels of expert systems such as DOCTORS, developed by Nippon Telephone & Telegraph Co., to help with diagnosis and referrals of patients with headaches.

The report is unique in presenting a usefully realistic and succinct overview of Japan's Fifth Generation Computer Systems project by ICOT, Britain's ALVEY project, work in the United States, and the European Community's ESPRIT Program, as well as a listing of over 150 systems being developed in Australia, with a detailed case study of one which is aimed at preserving some of the expertise about the operation of an iron ore sinter plant by a retiring general foreman. It is also unique for including discussions of the social (e.g. intellectual property, espionage, impact on human labour), psychological (e.g. what it means to be human, division of labour, how to relate) and legal (e.g. liability) factors. It presents a balanced, coherent and easily understood briefing for anyone concerned with artificial intelligence and how to cope with it.

**Manfred Kochen**
The University of Michigan
Ann Arbor

**Thinking Machines — The Evolution of Artificial Intelligence** *by Vernon Pratt* (Basil Blackwell, Oxford, 1987), pp. xii + 253, £19.50, ISBN 0-631-14953-8.

In the Preface to this book, Vernon Pratt, a philosopher, says that his interest in computers was originally stimulated by the threat they appeared to present to jobs, to autonomy through their power for control and surveillance and, according to some extremist proponents of artificial intelligence (AI), even to the dominance of *homo sapiens* on this planet. He confesses that as he immersed himself in the subject he became captivated by the computer's potential to make a creative contribution to the human condition, and expresses the hope that his book will be useful in the debate about how to diminish the threat and increase the potential. But he returns to this theme only in the very last paragraph of the volume, and then only obliquely. The text is devoted to tracing that part of the history of thought and science in the last 300 years that made the emergence of AI possible.

Pratt centres his exposition around three critical projects in the modern age: Leibniz's calculator, Babbage's analytical machine and Turing's pilot computer. Retrospectively these emerge as milestones in the development of AI, but he rejects the idea of a linear progressive development. There are continuities and discontinuities. Each of the three projects was an outstanding achievement within the context of the technological, economic, scientific and intellectual climate of its day. One great merit of this book is that it pays as much attention to this context as to the projects.

The three inventive giants shared certain features: all three developed their machines while engaged in solving theoretical and practical problems, even if their thoughts and dreams far outstripped the requirement of immediate applicability. Their competence and imagination comprised engineering as well as mathematics. Pratt emulates this combination by including illustrations and explanations of the construction of many machines and instruments, together with an account of the relevant history of mathematics and logic. Finally, they shared a dominant idea of the modern age: meaning can be represented by the manipulation of mechanisms.

Leibniz's calculator, constructed in wood by his workmen, solved the problem of mechanical multiplication beyond Pascal's earlier and clumsier method. His dreams went far beyond this achievement, though they too were stimulated by his practical experiences as a diplomat. The arguments and misunderstandings all around him were, he believed, the result of lack of precision in language. If language could be made as precise as mathematics, disagreements would be solved like algebraic equations.

Leibniz's calculator and his ideas on the mechanisation of reasoning fell into oblivion after his death since slide rules and log tables were more handy and more reliable than his machine for everyday calculations by merchants, navigators, administrators and astronomers. Furthermore, in the eighteenth century many scientists turned from mathematics to the life sciences and geographical exploration on the assumption that Newton had solved the problems of physical science. The production of Leibniz-type calculators continued, however, with minor technical improvements until the first quarter of the twentieth century.

It was Babbage in the 1830s who achieved a decisive conceptual advance in his several designs for the analytic engine. His seminal idea was to construct a machine that could use its own output as input for further calculations, and that could, like modern computers, manipulate symbol systems that stood not just for numbers but for the relation between non-numerical concepts, provided that this relation followed the rules of logic. Lady Lovelace, his collaborator, even conjectured that the analytic engine might compose music once the rules underlying harmony and composition were properly formalised.

The analytic engine was never actually built but remained in the design stage. It took more than a century before Lovelace's dream approached realisation. Pratt explains the delay by reference to economic factors: with the enormous growth of commercial and administrative organisations, the demand of the time was for ever faster and ever more reliable numerical machines rather than for mechanically produced music. This demand was met by the giant calculators constructed in the first half of this century. From Leibniz's rotation by hand, these machines had advanced from the use of mechanically rotating parts to the electronic flip-flop by the middle of the twentieth century.

In 1950 Turing posed the question "can machines think?" and answered it in the affirmative, even if at the time this could not be realised. He originated the metaphor of the mind as a computational machine which is the fundamental assumption of AI and has since come to dominate cognitive science. Turing arrived at the conclusion that there was, in principle, no difference on theoretical grounds between the power of the human brain and that of a computer. Pratt describes the development of mathematical logic and cybernetics that formed the basis of Turing's thought; Turing himself contributed to its further development.

In the concluding chapter, Pratt sees the emergence of AI as the result of the triumph of formalism over content in the last three centuries. Regrettably there is in this very good book no discussion of the intellectual controversies to which this triumph has given rise as the conceptual progress of AI has slowed down. The economic potential of the application of AI in expert systems (on which so many AI researchers now concentrate) can be exploited, even if none of them so far can pass the Turing test. What about the future? Pratt, perhaps wisely, offers nothing but that tantalisingly brief and ambiguous last paragraph of his book.

**Marie Jahoda**
University of Sussex

**Challenges and Change: Australia's Information Society** *edited by Trevor Barr* (Oxford University Press, Melbourne, 1987), pp. viii + 188, ISBN 0-19-554855-8.

The study of the information society has been popular among sociologists in the last three decades, as a way of analysing the change of a society from an industrial one to a post-industrial, or information-oriented, society. Since the early writings of Daniel Bell, Yoneji Masuda, and S. Nora and A. Minc, many social scientists have written about this change.

There is also another line of analysis, namely, an economic one. This approach studies the economic change of society at a macro-level, observing that in most of the developed, industrial countries there has been a massive change from an economy based on manufacturing industries to an economy based on production, processing and distributing information and services. This sector is the fastest growing one of an information economy. The pioneers have been Fritz Machlup, Mark Porat and Michael Rubin with their analysis of the US economy, and Kenneth Arrow and Don Lamberton with their writings on information economics.

Both these lines of thinking have contributed greatly to the present understanding of the information society. One of the latest examples is **Challenges and Change: Australia's Information Society**. It is a collection of articles written by Australian economists, social scientists and government officials about issues related to the Australian information society. The book has a clear message: Australia has turned into an information society, increasingly dependent on information and information technology. This has produced a number of problems, such as privacy, access to information, dependency on