# Generation Gap

**With the introduction of VLSI technology, we are now about to enter the Fourth Generation of computers. But the Japanese are already specifying the Fifth Generation**

Old men do not create revolutions, as the saying goes, and the director of the Japanese project to create the Fifth Generation of computers seems to have taken that to heart. In choosing 40 scientists from ten major corporations and government laboratories to work with him at the Institute for New Generation Computer Technology in Tokyo, Dr Kazuhiro Fuchi selected only those under the age of 35. The Institute was founded on 14 April 1982 with a sum of £330 million (to be spent over ten years), and is a joint venture between government and industry. Companies such as Fujitsu, Sharp and Toshiba are taking part in this ambitious project, which intends to leap over the present state of computer technology and create machines far in advance of those that are presently being designed.

The coining of the term 'Fifth Generation' has itself focused attention on the major advances in computer design in the past, and stimulated imaginative possibilities for the future. The first generation of computers were characterised by the use of thermionic valves, but these were made obsolete by the invention of the transistor. Second generation transistor computers were in turn superseded by machines using Large Scale Integration (LSI) technology, which allowed many transistors to be built into a single chip. We are at present at the end of this third generation of computers, but the late 1980's should see the fourth generation of VLSI chips become available. These Very Large Scale Integrated chips will have up to ten million transistors per chip, compared with the current limit of approximately a quarter of a million.

At present, International Business Machines annually spend over £1.1 billion on computer research and development, which makes the Japanese investment seem insignificant in comparison. The Japanese capital outlay is not purely profit-motivated, however.

The focus of science has shifted over the last hundred years from the harnessing of raw energy (in forms as various as electricity and the internal combustion engine) to the study of the most intangible form of wealth — information. Land, labour, capital and industry may have been the source of power in the past, but the future will favour those in control of information. Knowledge and the processing of information will be the keys to post-industrial society. So what is needed for this new society is an engine, a machine with automatic reasoning that can be applied to any factual problem or area of human endeavour with the mathematical precision and certainty of a computer. The engine that is currently being built by the Japanese is called a Knowledge and Information Processing System, or KIPS.

Humans are very good at converting sensory signals into cognitive forms — the state of play in a game of chess can be seen at a glance — but when it comes to taking decisions that depend on large amounts of data we soon discover our limitations. The rules of chess can be explained in a few minutes, yet the game is so complex that grandmasters see only a dozen moves ahead. However, in principle every problem to which reasoning applies can be broken down into a series of simple steps, each of which can be decided by applying rules of inference. This set of rules is known as predicate logic. Logical rules of inference apply to all problems, but for simple everyday decisions we aren't conscious of them.

**Logical Language**

PROLOG — an abbreviation of Programming Logic — was developed in the early 1970's by the Artificial Intelligence group at the University of Marseilles, though one of its chief developers and proponents is the American Robert Kowalski at Imperial College, London. Based around some of the principles of human logic, it is the language most likely to be used in the Fifth Generation computers. It is also particularly suitable for the creation and interrogation of databases and for educational applications

An expert needs more than a good brain — in the case of a doctor many years of training are required to accumulate medical knowledge. In the same way, a KIPS must have a data bank on which the rules of inference can operate. Furthermore, the system must be extremely user-friendly if the KIPS is not to demand its own breed of experts to operate it. A KIPS machine with which you can hold a conversation in the language of your choice must be a product of research into artificial intelligence — which is an extremely contentious area of study. Thus the targets that the Japanese have set themselves embrace a wide range of computer sciences: hardware, software, interfaces, expert systems (see page 72) and the problems of artificial intelligence.

The Japanese project has been conceived to look beyond advances in chip technology. As the density of transistors in integrated circuits increases, electrons have less distance to travel between each component, and hence the circuits will operate faster. However, the Japanese realise that mere speed is not enough, which is why so much effort is being put into the software. In a