I believe that given current technological trends, humanity will have its first artificats before the end of my lifetime, and if so, the consequences for humanity will be profound.

will be designing chip layouts as easily as ordinary compilers translate high-level code into machine language.

Another possibility is to imagine neuronal computers designed with such flexibility that their architecture can be easily specified by software [Minsky 1986]. This ability would avoid the need to redesign neurochips every time a new neurohypothesis is required testing.

The neurophysiologists will be quick to profit from the existence of neural computers to test their brain theories. A marriage of the two subjects is, thus, likely, so, intelligists will become biologists to an increasing extent, and the neurophysiologists will be getting heavily into AI.

Another technology likely to have an impact is optical computing. Recent research on bistability, that is, the two-state behavior of certain nonlinear optic devices, allows computing to be entirely optical and, hence, able to overcome such problems as crosstalk, which plagues electronic computing. Optical computing would be much faster than electronic computing, so the interest in this new technology is significant and growing [Feitelson 1988].

A third technology that is not yet well developed is molecular computing [Drexler 1986; Hameroff 1987; Langton 1989], which aims to use genetic engineering techniques, among others, to create substances capable of computation but at molecular scales. Molecular computing is important because limits exist to the number of transistors one can cram onto a two-dimensional surface without running into quantum effects. However, these limits can be postponed to some extent by introducing a third dimension into chips, thus piling the number of layers until a solid block is produced.

The great attraction of molecular computing is not only its (molecular) scale but the added advantages of biological adaptation, such as growth, self-repair, and learning. Recent and spectacular progress in superconductivity promises the possibility of superconducting proteins at room temperature, which would allow a huge quantity of such material to be packed together without worry of heat dissipation problems.

The Japanese Ministry of International Trade and Industry (MITI) is taking molecular computing seriously and, in 1984, promised $36 million to such research. Unfortunately, the U.S. government has been much slower. The same story is true for the European community.

Recent American research has shown that genetically engineered polypeptides can be metallized, thus giving them the advantages of electronic conductivity, even if superconducting proteins are not found, biologically based computing technology can take advantage of electronic conduction speeds.

Molecular biology has made so much progress in the study of bacteria over the last decade that more and more biochemists are moving up to multicellular creatures and studying such molecular mechanisms as embryological development, including how neurons grow and connect with other neurons. As the principles of these processes are discovered, it will become possible to grow computer brains according to seventh generation technology.

In short, in AI circles, the brain is in again, and research money is starting to flow to support brain-oriented computing. The Japanese have launched two projects of this type. One is called simply the Sixth Generation Project and the other the Human Frontiers Project. The National Science Foundation in the United States is now funding the Neuronal Computing Project, and the European Commission has launched its BRAIN project, so we should be seeing the first brainlike computing devices shortly.

Tomorrow's intelligists will probably be multidisciplined experts in the fields of microelectronics (UltraLSI), molecular (nano)electronics, neurophysiology, embryology, optical computing, and so on. Today's symbolic computing on monocomputer machines will probably be considered quaint.

As Machines Grow Smarter

This section attempts to give a gut feel about what it might be like to live in a world where computers are rapidly increasing their intelligence and discusses the feelings this development might evoke in human beings.

In my view, the biggest impact that smart computers will have on ordinary people will occur when machines begin having conversations with them. This achievement is still some time away. I would say it will be another five years before the first commercial conversational systems are ready. These machines will be capable of recognizing and responding to the simple utterances of their owners. Over the years, however, the sophistication of these systems will increase, until one day people realize they are having relationships with their computers.

Such advanced systems will be capable of learning and will probably be the products of sixth-generation neural computers, using hardware which is based on brain modeling. They will speak well and understand with breathtaking rapidity. Remember