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Leadership in Computer Technology

At a recent conference on computers in science about 40 leading experts presented lectures on developments in microelectronics and computers in their applications to various scientific fields.* The speakers were optimistic that exponential increases in the power and usefulness of computers would continue for another decade. In the future it will be feasible to handle problems of great complexity such as those encountered in geophysics. Superb graphics are in being and will be applied widely in such fields as biology, medicine, chemistry, and engineering. Artificial intelligence and particularly expert systems have entered an extremely useful phase. However, the spirit of optimism was tempered by concern about the eroding position of the United States with respect to foreign competition, particularly from Japan.

The Japanese have publicized their hope and expectation of becoming the world's leader in computer technology. They have announced two major efforts: The National Superspeed Computer Project and the Fifth-Generation Computer Project.† At the conference some doubts were expressed about the Japanese reaching their goals. But there was general agreement that the two new efforts would lead to substantially enhanced capabilities.

The Japanese have come a long way in microelectronics and computers during the past 10 years. Their success in capturing leadership in the world market for random access memories (RAM's) is impressive. In 1970 they were no factor. By 1974 they had obtained a 5 percent share of the market for 4k RAM's. In 1978 they shocked Silicon Valley by capturing 45 percent of the sales of 16k RAM's. For a time in 1982 they obtained as much as 70 percent of the world market for 64k RAM's. The Japanese claim to have computers that are faster than American models, including the Cray 1 and Cyber 205. However, the claim has not been verified.

Microelectronics and computers are dynamic sectors of the economy and will probably continue to be for another decade or more. Loss of leadership in this field would have serious consequences for this nation's economy and defense. In their efforts to attain world leadership Japanese companies enjoy advantages. Their government helps rather than hinders them. They can obtain financing at much lower rates than U.S. companies can. They find it feasible to engage in ventures where the payoff is many years distant. The futuristic projects will enjoy substantial government subsidies. Through direct and indirect mechanisms the Japanese are freed from unwelcome imports of competing goods. Their educational system emphasizes mathematics and science in the secondary schools, and the universities produce twice as many engineers as ours do.

One area in which the Japanese seem particularly eager to excel is artificial intelligence. In this field the computer deals in symbols rather than numbers. Professor Edward Feigenbaum of Stanford believes that we are at the beginning of a second computer revolution and that ultimately applications of artificial intelligence will become more important than number-crunching. Calling to mind Pearl Harbor he said, "At dawn we slept."

The comment is almost, but not quite, true. Repeatedly U.S. companies that have not pursued vigorous R & D programs have been sitting battleships. But companies that have implemented vigorous programs have fared reasonably well. Our strength has been in imaginative leaps. To capitalize on our strength we must among other things increase the flow of computer scientists from the present level of about 250 Ph.D.'s per year. Recently, many companies have acted to be helpful in doing this. Moreover, at seven universities costly facilities have become available for research on very large scale integrated circuits. These moves are helpful, but there is no occasion for complacency.—PHILIP H. ABELSON

*"The First Annual Conference on Computers in Science," sponsored by *Science* in cooperation with Scherago Associates and organized by Dennis Smith and Peter Friedland, was held in Chicago on 7 to 9 December 1982. †See B. L. Buzbee, R. H. Ewald, W. J. Worlton, *Science* **218**, 1189 (1982).