Semiconductor Competition: Airing the U.S.–Japan Issues

Some leaders of the U.S. semiconductor industry have been raising a hue and cry over a perceived threat from their Japanese counterparts to dominate what was once a nearly exclusive American turf—microelectronics. On the American side, the tone of the discussion has been less than diplomatic, and there have been inflammatory articles in the business and trade press, some of which contained illustrations that unflatteringly caricatured the Japanese or featured such quotes as "they are out to slit our throats." The Japanese, in keeping with their reluctance to engage in head-on confrontations, have refrained from responding in kind. Nonetheless, the atmosphere at an electronics meeting this spring, attended by leaders of both sides, was described by one observer as tense.

Last month, there was an unpublicized attempt to reverse the polarization building up between Americans and Japanese. In a meeting at Stanford University, representatives of Japanese companies were given a chance to portray the controversy as seen from their point of view and to respond to American criticisms of the past year. Intended mainly as a chance to air the issues, the meeting was only partially successful, in part because not all the heavyweights in the dispute were present, and in part because of the continuing reluctance of the Japanese to engage in direct debate.

Attendees agreed, however, that the successful maintenance of a friendly atmosphere marked a major step forward in the relations between U.S. and Japanese microelectronics industries. Also, a presentation by Michiyuki Uenohara of the Nippon Electric Company helped pull together what had previously been known only in pieces about a principal bone of contention, the cooperative effort of industry and government in Japan to develop the next generation of microelectronic circuits.

Microelectronic circuits are more often called integrated circuits (or simply IC's) because all the components—such as transistors, diodes, resistors, and metal interconnections—needed for such functions as computer logic or memory are fabricated directly in the surface region of a small chip of semiconductor material, nearly always silicon. One measure of the advancing technology is the number of basic circuit functions that can be packed onto a single chip. A chip is typically from 4 to 6 millimeters on a side. In the case of the computer memory, the basic function is the storage of a single binary bit of information, and the density of storable bits has been roughly doubling every year since 1962. At present, the largest random access memory chips can store about 16,000 (or 16K) bits. But announcements of 64K-bit memories are already beginning to appear, with production possible for next year.

The 64K-bit memory chip puts semiconductor manufacturers into the next generation of microelectronics, which is called very large scale integration (VLSI). Since those who can first manufacture useful VLSI circuits in quantity will, if past performance is any indication, dominate the market for such circuits for the duration, it is essential not to fall behind.

Claim of Unfair Competition

While U.S. firms have jockeyed hard among themselves for leadership in riding this wave of advancing technology, American semiconductor manufacturers as a group have been world leaders, retaining about 60 percent of the worldwide semiconductor market in the 1970's. But technology is not the only thing that changes. Among the new developments is the combination of an ever increasing miniaturization, which allows more computational power to be put on a chip, with the growth of production capacity. As a result, some have predicted, there will soon be more computing power manufactured than existing markets (consisting primarily of computer memory and electronic calculators) can absorb. At the same time, the Japanese have built up both their technological sophistication and their production capacity sufficiently to begin to threaten U.S. markets as part of a strategy to make computers the next big export item for the country (*Science*, 18 March 1977, p. 1175).

Thus, American companies are simultaneously faced with a diversion of engineering talent as they struggle to find new ways to use microelectronics in consumer-oriented products and a need to perfect the much more advanced and expensive processing technology required to successfully compete in VLSI circuits. The issue is much broader than simply the survival of some electronics companies; falling behind could adversely affect U.S. military security and foreign trade balances.

Leaders of the U.S. semiconductor industry have vowed not to permit a repeat of what they see as defeats in textiles, steel, automobiles, and consumer electronics brought about by failure to appreciate the Japanese threat soon enough. By now a rather familiar catalog of complaints exists under the general theme of unfair competition, including (i) government subsidies in Japan to manufacturers of exported items, (ii) lower import tariffs in the United States than those in Japan, (iii) the inscrutability of the Japanese way of distributing goods, (iv) official and unofficial "buy Japanese whenever possible" policies, and (v) the one-way flow of technical information from the United States to Japan but seldom the reverse. Some U.S. industry executives have called for the establishment of a parity in microelectronics trade whereby each country will export roughly the same amount of goods to each other.

Symbolizing U.S. apprehensions is the cooperative government-industry VLSI program in Japan. Now into its third year of operation, the first public information about the project's goals, organization, and costs was released in this country only last December. The shroud of misinformation resulting from a long period of rumor and hearsay only intensified fears of unfair competition. Under the auspices of Japan's Ministry of International Trade and Industry (MITI), a multi-hundred-million-dollar effort involving that nation's top computer and electronic firms was under way to develop the technology necessary for VSLI. Whereas half the funding was coming from the Japanese government and the companies were required to cooperate among themselves for the duration of the project, U.S. semiconductor companies were getting no federal money for VLSI and were forbidden by antitrust laws to pool their resources. As discussed earlier, some microelectronics leaders in the United States expressed their concerns in the bluntest of terms and a general atmosphere of ill-will has been the outcome.

But, explained John Linvill of Stanford, who organized the sessions attempting to depolarize the situation

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(which coincidentally took place during the last week of the Carter-Begin-Sadat summit at Camp David), all semiconductor companies, Japanese and American, right now have a vested interest in some degree of cooperation. Neither side will make a cent from VLSI until some still rugged problems are overcome, including processing technology and automated design of circuits that will be much too complex for humans to deal with. With this much in common, would it not be better to stop squabbling and get on with solving these problems whose solution would benefit all? Such was the motivation for the Stanford get together, which was part of the Annual Review of Solid State Electronics, held to allow those companies contributing funds to the university's electronics program to see what they were getting for their money.

Uenohara's description of the Japanese VLSI Technology Research Association seemed aimed at allaying fears and downplaying competition as much as possible. He explained that MITI initiated the VLSI project primarily to bring into being the microelectronics technology necessary for advanced computers. For this purpose, approximately 72 billion yen ($382 million) will be spent over the period 1976 to 1979, of which about 42 percent is in the form of repayable tax-free loans from the Japanese government to the five participating companies.* In contrast to earlier government-sponsored projects, management by MITI is minimal, and therefore the companies involved formed the association to coordinate their activities.

Items to be addressed by the association include semiconductor crystal technology, the fabrication of structures with dimensions of about 1 micrometer or less (compared to 5 micrometers at present), other processing technologies (such as etching surfaces with plasmas rather than chemicals), finding ways to design complex circuits, developing methods of economically testing complex circuits to guarantee they work, and development of actual devices. To accomplish these ends, the association set up two kinds of laboratories. To work on the basic technology, it established cooperative laboratories involving all five participants at one site. For development of device technology, it established two group laboratories, at least on paper: Computer Development Laboratories (Hitachi, Fujitsu, and Mitsubishi) and NEC-Toshiba Information Systems Laboratories.

Physically, the group laboratories are scattered among the companies, and, said Uenohara, there is little exchange of information or transfer of personnel between them. Thus, he emphasized, the vaunted Japanese cooperation exists mainly at the basic technology level. When it comes to building products, their companies are as competitive among themselves as Americans are. In fact, Uenohara added, there is little mobility of personnel because of the tendency of Japanese employees to stay for life with their original employer, whereas the situation is just the opposite in the U.S. semiconductor industry. Thus, there are historical differences in approach to integrated circuits among Japanese companies that makes it harder for them to develop products jointly than it would be for U.S. firms if they were so inclined.

Japanese Export to Live

Uenohara also served up some nontechnological considerations that he said were important to the issue of U.S.-Japan competition. He referred to the well-known necessity for the Japanese to sell high-technology, value-added items overseas to pay for the food and energy needed to feed and fuel a nation of 110 million that is poor in natural resources. Just as important, he said, was the tremendous insecurity engendered by that need. One example, referred to indirectly, was the continued Japanese insistence on producing as much of their food as they can even though it could be bought cheaper from the United States. In the same vein, because of the importance of computer technology to the industrial world, the Japanese feel they cannot be without a home-grown computer industry.

He did not say, however, that the Japanese would not try to market VLSI circuits or the advanced computers that will contain these circuits in the United States.

An after-dinner panel discussion followed up some of these themes, but also pointedly showed that a long road lies ahead of peacemakers in the microelectronics business. Opening the session was Robert Noyce, chairman of the Intel Corporation, Santa Clara, California. In the words of one observer, Noyce came out smoking. He reiterated his much quoted throat-slitting charge, although qualifying it somewhat. After a compliment to the Japanese by judging that they embodied American work ideals better than Americans themselves, Noyce dealt with the theme that the United States is an open market to the Japanese but Japan is not open to Americans. He ended with the declaration that, now that the two countries' microelectronics capabilities were nearing parity, opportunities for trade between the two should be equal, too. (In point of fact, the value of U.S. semiconductor exports to Japan is about twice that of imports, although that ratio has been slipping each year.)

Uenohara fielded Noyce's challenge but not cleanly. In a remarkable admission, he agreed that Japan was not all that open in competition, but that a thousand years of tradition and a deeply ingrained national sense of insecurity could not be erased overnight. The Japanese would work to change, he said. Not addressed was the issue of how to achieve parity in trade.

Other Japanese panelists were Takuo Sugano of the University of Tokyo and Tsugio Makimoto of Hitachi, who, like Uenohara, had spent time in American universities. Neither directly addressed the issue of microelectronics competition. Sugano concentrated on the difficulties stemming from the differences between the languages of the two countries. For example, Americans do not need to learn Japanese whereas English is the language of international commerce. He suggested that, if more American businessmen were to learn Japanese, there would be a more symmetrical flow of information and a greater opportunity for American industry to expand its market to Japan.

Makimoto also mentioned language-related barriers to understanding, as well as a number of other differences stemming from cultural and geographical characteristics of the United States and Japan. Makimoto ended by noting that, although American and Japanese companies have much in common through their faith in the future of microelectronics, competition will continue because of the wide gap between the present capability and the ultimate technological limit of integrated circuits.

Whether this opportunity to air the issues at Stanford will lead to a decline in the currently bitter atmosphere remains to be seen. Nothing like a frank discussion of international trade policy took place. Linvill thinks that the friendly atmosphere that prevailed throughout might be the first step toward a rapprochement. The big question remains, however: As long as the Japanese are tied to their "export or die" outlook, how can one expect them to accept parity in microelectronics with the United States?—ARTHUR L. ROBINSON

*The five participating companies are Nippon Electric Company (NEC), Japan's largest producer of semiconductors; Fujitsu, Japan's biggest computer maker; Hitachi; Mitsubishi Electric Corporation; and Tokyo Shibaura Electric Company (Toshiba).