A Global Supercomputer Race for High Stakes

Although U.S. companies currently hold a lead in technology and sales, Japanese manufacturers are now producing fast machines and slashing prices

Tokyo

When Tohoku University, a public institution in Japan, went shopping for a supercomputer last year, executives at Cray Research, Inc. thought they finally might have a shot at winning a competitive bid in the Japanese government market.

Cray, the leading U.S. manufacturer of supercomputers, has long dominated sales of the machines around the world—except in Japan. This time, however, it was bidding under new procedures for purchasing supercomputers that are supposed to make it easier for foreign companies to compete.

But Cray came away empty-handed, losing yet another sale to a Japanese competitor, this time to Nippon Electric Corporation (NEC). Even seasoned Japan-watchers say they are amazed at the lengths to which NEC went to clinch the deal. Cray dropped out of the competition early on when NEC offered a substantial discount on its machine. But even when NEC was the only company left in the running, it still went through several rounds of negotiations with the university. Each time, the company cut its price still further. NEC ended up discounting its $20-million machine about 80% in a virtual giveaway.

Under the new bidding rules, which were adopted a year and half ago by the Japanese government under pressure from the United States, Japanese public universities and national laboratories have purchased five supercomputers. All of them were made in Japan. In fact, during the past several years, out of 27 supercomputers purchased by Japan's public sector, all but two are Japanese-made—and those two, produced by American makers, were purchased under special circumstances that were noncompetitive.

American companies are also having a hard time making sales in the private sector in Japan. Although U.S. firms account for about two-thirds of the supercomputers installed around the world, they have managed to capture less than a fifth of all the units sold in Japan.

Japanese computer executives contend that their computers are often purchased because they are technically compatible with systems already in place. But the inability by U.S. manufacturers to crack the Japanese market has prompted high-level concern in the American computer industry and the U.S. government. Part of the concern stems from the immediate loss of sales in a market that is growing rapidly and is second only to the domestic U.S. market. Already, Japan accounts for about one-third of the supercomputers installed worldwide.

But a deeper worry is that Japanese manufacturers may be shutting American companies out of the Japanese market to build up their own manufacturing base and hone their technology for an assault on the U.S. and other markets. This is a familiar strategy. It has proved spectacularly successful in areas such as semiconductors and consumer electronics. The Japanese are not invading the American supercomputer market yet, mainly because they lack technical support staff and software needed by American customers, some experts believe.

A key to the impending global competition in supercomputers is technology. At present, American companies hold a significant lead in most areas, according to recent reports by a committee of the Institute of Electrical and Electronics Engineers (IEEE) and an interagency committee of the Federal Coordinating Council on Science, Engineering and Technology.* But the reports warn that the Japanese are gaining quickly.

The stakes are high. The worldwide market for supercomputers, which sell for about $10 million to $20 million each, is projected to be about $2 billion next year, according to analysts' projections. Perhaps more important, supercomputers are a critical tool for improving competitiveness in a growing number of industries. They are now being used to simulate car crashes, study fluid dynamics, evaluate seismic and geologic data in oil exploration, design semiconductor chips, aircraft, and new chemicals, and perform complex economic analyses.

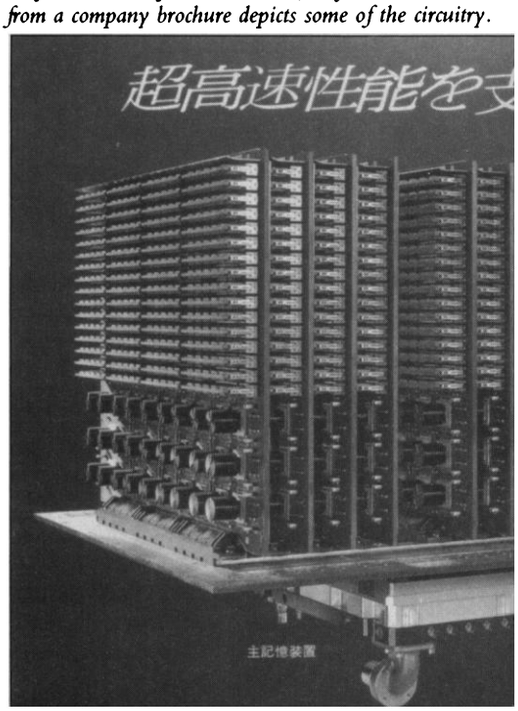
"When companies don't use supercomputers as fundamental tools, then the whole economy loses," says Larry Smarr, director of the National Center for Supercomputing Applications at the University of Illinois.

Supercomputers are also commonly used to forecast weather and to help basic researchers solve complex calculations in physics and math. They are also vital to national security, for they are used to crack intelligence codes and design weapons.

Only two principal companies in the United States currently sell high-performance supercomputers, but together they reign over the international market. One is Cray and the other is ETA Systems, Inc., a subsidiary of Control Data Corporation. Both are based in the Minneapolis–St.Paul area. Cray alone has installed nearly 60% of the supercomputers around the world.

Cray's success is based in part on its achievements in hardware technology. To put this in context, in the world of computers, there are scalar and vector processors. Most computers, like personal computers, are scalar processors, which compute by breaking down a task into separate steps and performing each step consecutively. This is like picking up one item at a time in a supermarket, checking out, and repeating the whole procedure for each item on a shopping list. A vector processor can perform several steps simultaneously—a procedure akin to picking up all the items on a shopping list before going through the checkout line.

Fujitsu's entry. *In December, Fujitsu unveiled the [illegible] from a company brochure depicts some of the circuitry.*



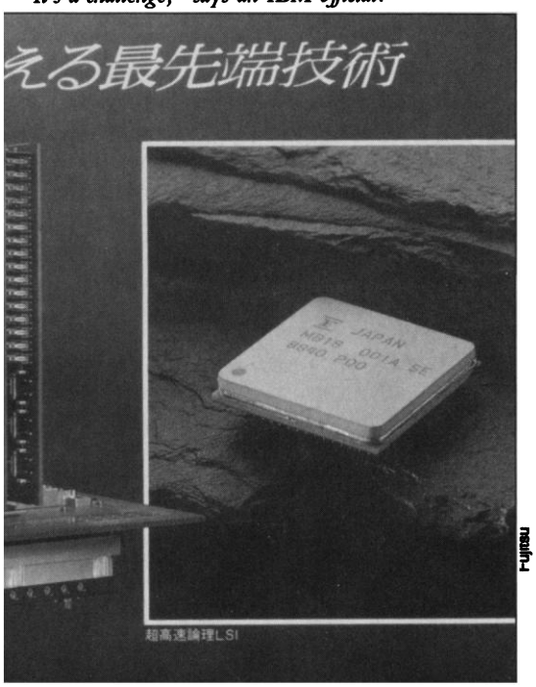
*"U.S. Supercomputer Vulnerability," 8 August 1988, Scientific Supercomputer Subcommittee of the Committee on Communications and Information Policy, IEEE; Annual Report, March 1988 (DOE/ER-0368), and "The U.S. Supercomputer Industry," December 1987 (DOE/ER-0362), both written by Committee on Computer Research and Applications Subcommittee on Science and Engineering Computing, Federal Coordinating Council on Science, Engineering and Technology and released by the White House Office of Science and Technology Policy.

Supercomputers nowadays have at least one vector processor. More sophisticated supercomputers have multiple vector processors that can work in parallel, either running different jobs simultaneously or running one job over two or more processors. Cray's best machine has eight vector processors. The company plans next to build a 16-vector parallel processor using a new kind of logic chip made from gallium arsenide.

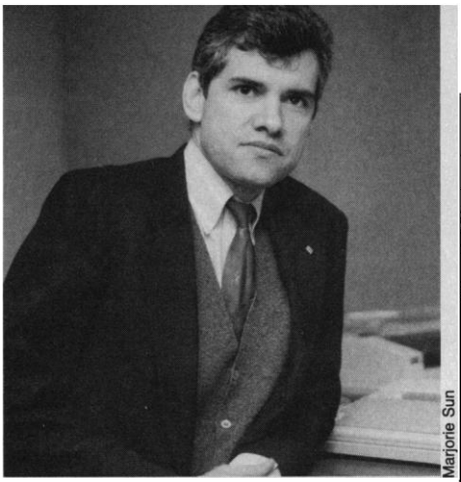
Cray also has a major advantage over Japanese competitors because a much wider range of applications software exists for its machines. Cray and ETA machines are also more compatible than the Japanese versions with work stations, in which many individual, less powerful computers can network with a supercomputer.

A third U.S. contender is International Business Machines (IBM). IBM currently sells a souped-up version of its basic 3090 mainframe with a single vector processor, and has distributed in the United States "several" 3090s with 6 vector units, says Troy Wilson, manager of the applications support center in IBM's Kingston, New York laboratory. The company is expected eventually to enter the high-performance supercomputer market with a machine that is now in the preliminary stages of development, but it is unclear when it will make its debut. In 1987, IBM joined forces with Cray's former top computer designer, Steven Chen, to design the machine.

The Japanese, however, are narrowing the gap in hardware and software. They already produce the world's fastest single processors and are making them even faster. In December, Fujitsu announced plans to enter a new, fleet-footed contestant into the international supercomputer race. The new model, scheduled for shipment next year, would be the world's swiftest single vector processor. Fujitsu says the machine will run at 4 gigaflops at peak performance, 3 times faster than the best single vector unit on the market now, which is also made by Fujitsu. Hitachi and NEC also make very fast single vector processors. Wilson of IBM says of the proposed Fujitsu machine, "There's no question that it's a challenge."



world's fastest single processor machine. This illustration "It's a challenge," says an IBM official.


Marjorie Sun

Raul Mendez. *Heavy discounting by Japanese manufacturers is "a strategic investment."*

Japanese companies have yet to build machines with multiprocessors, a step that requires a leap in technical sophistication. Nevertheless, the IEEE panel said, given that the Japanese have developed the most powerful individual processors, Japanese supercomputers "could far outstrip the best of the U.S. machines once [they] catch up in parallel processing, an area where they are hard at work."

Raw speed in a supercomputer, however, isn't everything, American researchers emphasize. Judging a supercomputer on peak performance is like evaluating a car only at top speed. A more important consideration is how the computer functions on the particular software a user needs. "Speed depends entirely on the [software] application codes," says David Kuck, director of the Center for Supercomputing Research and Development at the University of Illinois. Or, as Kenneth Wilson of Ohio State University puts it, "A supercomputer may be good on a racetrack, but not all that good in city traffic."

The Japanese are on par with or even ahead of the American makers in some key areas of software development. "Systems software of the Japanese supercomputers is already world-class," the IEEE panel said. The Japanese also are a leader in the development of vector compilers, software that translates programs into instructions that a computer understands, and maximizes the performance of vector processors. "Japanese compilers are very competitive," says Wilson of IBM.

Growing Japanese technological sophistication is clearly worrying U.S. government and industry officials. But to some, the biggest threat may be in the marketing tactics of Japanese supercomputer companies. According to some observers, the chief problem U.S. manufacturers face in cracking the market here, particularly in the public sector, is price-cutting.

Japanese manufacturers make big cuts in their supercomputer prices to win customers, especially universities and laboratories. With a sale to a public institution, they get access to academic researchers who will develop important software for their particular machine, gain prestige from the association, and establish what a company hopes will be long-lasting loyalty among users. Michiyuki Uenohara, NEC senior executive vice president and director of research, said in an interview, "Having university researchers develop software that will help us is extremely valuable."

Norman Kreisman of the U.S. Department of Energy, who tracks supercomputer policy, says that "in every single case in which a Japanese public institution has bought a supercomputer, the Japanese have sold their machines 80% off list—even if it's the sole source." In contrast, Cray senior vice president for marketing Edward Macy says that his company in some cases will drop its prices by 5 to 10% for customers who buy multiple systems, but even that is "exceptional."

One feature of the Japanese industry particularly troubles U.S. officials: Because the Japanese supercomputer companies are part of giant conglomerates, they are better placed than the relatively small U.S. firms to wage a price war. Hitachi, NEC, and Fujitsu had combined sales from all their operations of more than $56 billion last year, so losses incurred from deep price cuts on supercomputers are easily absorbed.

As one scenario goes, the Japanese will knock out the smaller American supercomputer makers by slashing prices and then ultimately square off with IBM. Smarr points out that Japanese supercomputers are designed to be compatible with IBM's world of 3090s. This compatibility coupled with Japan's success in producing very fast single processors increases the machines' selling appeal to the business community, which is a huge and expanding market, Smarr and others say. "The real battle in supercomputers is between the three Japanese companies and IBM, rather than Japanese and Cray and ETA," Smarr remarks.

Indeed, 2 years ago, Makoto Kuroda, then a vice minister of MITI, told top U.S. officials visiting Tokyo that the American

supercomputer makers "are too small to compete effectively in [the] Japanese market," according to a U.S. State Department cable from Tokyo reporting his comments. American supercomputer makers, Kuroda said, are an "anachronism" at a time when the computer industry is dominated by giant Japanese companies and IBM. His remarks created a "furor" in the Administration, said former Commerce Department official Clyde Prestowitz in his recent book, "Trading Places: How We Allowed Japan to Take the Lead."

Kuroda even went so far as to contend that if the United States wants to remain competitive with the Japanese, then "small U.S. manufacturers should either be nationalized or be absorbed by major U.S. groups. . . . The [Japanese government] does not tell government-funded universities to buy Japanese supercomputers; they do so because the discounted price is advantageous and they can be expected to continue this practice."

Raul Mendez, director of the Institute for Supercomputing Research in Tokyo, a subsidiary of Recruit Company that has bought Japanese and American supercomputers, says that heavy discounting by the Japanese companies, "is not a new practice. IBM and others have done this before, too. They've even given machines to universities. It's a strategic investment." (For example, IBM has donated a 3090 computer with six processors to Cornell University.)

Mendez also reiterates a point made by the Japanese supercomputer firms that he says is not well recognized by many Americans. "In Japan, the most important point to take into account is that universities that have a system in place are already locked into it because they will otherwise have to convert millions of lines of [software] code to run on another machine," he says. "As a result, when universities upgrade their systems, the maker that they've been with over the years is a shoo-in."

Yoshikazu Hori, president of Cray Research Japan Limited, acknowledges that universities and labs have long-standing relationships with Japanese makers. "We cannot penetrate the government market" as it exists now, Hori said in an interview.

The IEEE report says that the ability of Cray and ETA to compete against the Japanese is also compromised by their dependency on the Japanese for some semiconductor components. Some of these Japanese chip makers are the same companies that compete against the Americans in supercomputing manufacturing, including Fujitsu. ETA has reported that Japanese suppliers have actually withheld leading chip technology in some cases. Macy says that Motorola is now a prime supplier to Cray, but for some chips Cray still relies only on the Japanese.

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In some respects, American supercomputer makers have not helped themselves in breaking into the Japanese market. ETA was late last year in installing the machine at the Tokyo Institute of Technology. (The national institute purchased the machine under noncompetitive procedures.) Then it had problems getting the computer up and running. In a culture where punctuality is almost an obsession, the Japanese press and others seized upon the delays and the operational problems as evidence that U.S. supercomputer makers and their products are unreliable.

Hori notes that Cray had only one salesman in its Japan office when he joined the company last April. "Customer coverage was poor." he says.

While the U.S. has been complaining about access to Japan, some Japanese executives and government officials grumble about access to the American market. Uenohara of NEC said that the United States "is not open" to Japanese supercomputer makers. Indeed, there are only four Japanese supercomputers in the United States even though the Japanese makers have teamed up with American representatives to help with marketing—Fujitsu with Amdahl, NEC with Honeywell, and Hitachi with National Advanced Systems.

Uenohara and other Japanese like to cite as an example the fact that the Massachusetts Institute of Technology last year dropped plans to purchase a NEC supercomputer after receiving a warning letter from the Commerce Department. But Administration officials note that NEC had proposed to heavily discount its machine to MIT, as it did with Tohoku University. This situation prompted the Commerce Department to caution MIT that the school might be subject to an "antidumping" investigation, which is triggered when a foreign company is suspected of selling an important product below cost.

But it is hard to take too seriously Japanese complaints that the U.S. market is closed when Uenohara and Hiroshi Watanabe, executive vice president of Hitachi, also say that Japanese makers lack adequate software to meet the needs of American customers and technical support to sell widely in the United States. "That's why Hitachi's presence in the U.S. is almost zero," said Watanabe with regard to supercomputers.

So far, the U.S. government has taken limited steps to tackle the foreign trade problems with supercomputers. The Reagan Administration's most visible attempt to open up the Japanese market was in getting the Japanese government to change its procurement process. But no U.S. sales have resulted and, as a supercomputer expert in Tokyo points out, the agreement did not spell out any penalties if Americans continued to lose out.

Cray itself says it does not want tariffs or quotas imposed. "We want a level playing field," Macy said. Cray also would like "a relaxation" of American export controls. The company acknowledges the need to protect national security, but some of Cray's older models are still very stringently controlled, Macy said.

Exactly what steps the federal government should take is a matter of considerable debate, but there seems to be some sentiment that it should assist U.S. firms in maintaining their technological lead.

The chief existing federal program is an effort run by the National Science Foundation, which in 1985 established five supercomputing centers across the nation. Funding for the program has increased dramatically—a 35% jump to $54 million has been proposed by the Administration for fiscal year 1990—but most of the money for has been used to buy hardware and for services. The IEEE panel and Kuck, who is a software expert, urge the federal government to spend more on software development.

The IEEE and the federal committee have called for a concerted response by industry, government, and academia in the United States to meet the Japanese challenge. "The challenge is to find an acceptable institutional framework," the IEEE panel said.

An Administration official says, "If we keep wasting our time on agreements that are merely procedural [like changing the bidding procedures], we won't get anywhere. Trying to open up the Japanese market isn't enough. Without some kind of government-sponsored initiative, U.S. supercomputer makers will have a difficult time. Without help, 5 years from now, U.S. companies will have a significantly smaller share of the market." ■ **MARJORIE SUN**

Marjorie Sun recently spent 2 weeks in Japan to report on science and technology there. Part of the funding was provided by a grant from the Ogasawara Foundation, a private foundation in Tokyo.