INTERNATIONAL BUSINESS

Computers and the Coming of the U.S. Keiretsu

by Charles H. Ferguson

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No matter that the United States still leads in developing the most innovative technologies. If U.S. and European companies continue business as usual, they will either fail outright or become, in effect, local design and marketing subsidiaries of Japanese companies that will dominate a $1 trillion world hardware industry. The endangered list includes most of the U.S. computer, office equipment, and imaging industries, from high-flying newcomers such as Apple, Compaq, Conner Peripherals, and Sun Microsystems to established giants such as DEC, Xerox, Hewlett-Packard, and Kodak. Also at risk are European companies such as Olivetti, SGS-Thomson, Philips, and Siemens and the allegiances of Korean followers such as Samsung and Hyundai.

On the surface, no crisis is visible. The world market share of the U.S. computer systems industry has declined only modestly—from 70% in 1980 to approximately 60% today. Japan holds only 20% of this market.

But market share is measured in gross revenues; and U.S. and European computer companies have been paying an increasing fraction of those revenues to vertically integrated Japanese components and hardware suppliers, who are also their primary future competitors. Japanese industry may well control more than 50% of the hardware content of worldwide personal systems markets within five years. In 1989, the United States for the first time became a net importer of computers, running a small deficit; imports hold 30% of the U.S. domestic market. The computer trade balance with Japan went from a small surplus ten years ago to a $6 billion deficit in 1988, and it continues to deteriorate.

Why is this happening? The information systems industry is being destabilized by its own technological trajectory. Digital technology is progressing at astounding speed, ushering in a new era of standardized, inexpensive personal systems designed and assembled from low-cost, mass-produced components. Companies with excellent process technology, capital-intensive components production, and flexible high-volume assembly will dominate the hardware value chain.

We are witnessing the digitization of everything. Previously unrelated industries—cameras, computers, stereos, photocopiers, typewriters—are converging to form a huge, unified information technology sector, itself based on common digital components and standard interfaces. Increasingly, competition in all kinds of hardware is driven by the same new logic governing competition in computers—growing commoditization of product markets and growing advantage for companies with superior components technologies, manufacturing systems, and strategic leverage. The most profound advantages will go to companies that have access to patient capital, that maintain close links with component and equipment developers, and that can afford huge, continuing expenditures for R&D and capital investment.

These facts play directly into the strategic and technical strengths of Japanese companies such as Canon, Matsushita, NEC, and Sony. Such companies are actually diversified, vertically integrated corporate complexes, many of them embedded in financial-industrial groups called keiretsu. They are able to make long-term investments in technology and manufacturing, command the supply chain from components and capital equipment to end products, and coordinate their strategic approaches to block foreign competition and penetrate world markets. (See the insert "A Brief History of Japan's Keiretsu.").

In contrast, U.S. industry has superior design skills, but it is largely fragmented, undercapitalized, and shortsighted. It has failed to develop the structures, strategies, and operational techniques necessary for commercial

A Brief History of Japan's Keiretsu by: Marie Anchordoguy

The Japanese keiretsu—societies of business—take two primary forms. Bank-centered keiretsu are massive industrial combines of 20 to 45 core companies centered around a bank; they enable companies to share risk and provide a mechanism for allocating investment to strategic industries. Supply keiretsu are groups of companies integrated along a supplier chain dominated by a major manufacturer.

There are six major bank-centered keiretsu in Japan: Sumitomo, Mitsubishi, Mitsui, Dai Ichi Kangyo, Fuyo, and Sanwa. The first three are direct descendants of the pre-World War II, family-owned *zaibatsu*. The U.S. Occupation authorities broke up the zaibatsu, blaming them for Japan's military machine and arguing that a capitalist democracy was impossible with some 25% of the nation's economic activity concentrated in a few groups. But by the mid-1950s, the companies of the old zaibatsu began to reassemble around the core banks.

The government actively encouraged the rebuilding of producer groups for two primary reasons. First, it assumed that interlocking ownership and close buyer-supplier relationships would help keep out foreign imports and investment. This was a time when Japan was, as was inevitable, pressured to open up its markets officially. Second, the government was concerned with concentrating scarce resources in industries deemed critical to Japan's long-term economic security. It felt that the groups, with their strong bank backing and diversified risk, could be directed by the government into strategic industries.

Government encouragement proved prescient. Today the keiretsu are the blue chips of Japanese industry. Though the 182

success in the markets created by its own innovations. Many European companies have clearer strategic vision, but they are starting from far behind and need U.S. cooperation for both technology and market assessment. With a few exceptions, both the U.S. and European industries lag far behind Japanese industry in rapid, integrated design for manufacturability and in flexible mass manufacturing.

As a result, Japan could dominate world hardware markets even though U.S. companies, universities, and standards organizations still define the state of the art in computer science, systems architecture, innovative design, networking, software, and digital communications—even in semiconductor memories, a $10 billion world market the United States has all but lost.

Still, while the industry's technological direction is inevitable, the further decline of U.S. and European companies is not. Several companies show signs of a new strategic vision in the form of embryonic alliances, many created by IBM or the Europeans. Yet these efforts remain haphazard and inadequate. To compete in the new digital information industry, U.S. and European companies must expand their alliances into a new industrial architecture, one that reflects the new architecture of digital systems. They must build large-scale corporate families that are strategically cohesive, yet entrepreneurial and companies that make up the core of the six groups account for only about 10% of the companies on the Tokyo Stock Exchange, more than half of Japan's largest 100 companies are group members. Virtually all of Japan's top city banks, trust banks, insurance companies, and computer, telecommunications, and semiconductor makers are group members. In the late 1980s, these six keiretsu earned some 18% of the total net profits of all Japanese business, had nearly 17% of total sales, held over 14% of total paid-up capital, and employed almost 5% of Japan's labor force.

There are close relations between banks and group companies, often cemented by bank holdings of some 5% to 10% of member company shares. Today, when many Japanese companies are flush with cash, the financial function of the main bank has become less important, although group banks still play an important role in providing backing to new, risky businesses and in helping member companies in trouble.

The keiretsu characteristically have interlocking directorates and presidents' clubs so that the chief executives of the principal companies can meet. Group members also typically purchase a small amount of each other's shares, usually 2% to 5%, and agree not to sell them, a practice called mutual shareholding. In all, mutual shareholding accounts for some 15% to 30% of member companies' stock. Including "stable share holding" agreements with other large institutions, some 60% to 80% of keiretsu company shares are never traded, so managers do not have to worry about takeovers and can focus on long-term issues.

flexible. They must form uniquely American (or Euro-American) versions of the Japanese keiretsu, integrating the manufacturing resources of companies from Korea, Taiwan, and Singapore. They must act with imagination and daring.

The New Facts of Information Technology

A personal computer with an Intel 386 microprocessor costs about $6,000 and delivers about 3 million instructions per second (MIPS), equivalent to IBM's most powerful mainframe computers of 20 years ago, before PCs existed. In contrast, a high-performance mainframe system costs about $10 million and delivers about 100 MIPS. Divide price by performance, dollars per MIPS, and the PC gives you 50 times more value than the mainframe. This gap will continue to widen; within 5 years, PC microprocessors will deliver 20 MIPS or more for the same price.

There is more. Look inside a mainframe processor and you will find hundreds of expensive, high-speed components embedded in elaborate packaging and power, cooling, and communications systems, as well as a main memory with several thousand memory chips. But when you look inside the new Compaq LTE laptop computer, you will find one microprocessor, one floppy disk drive, one hard disk drive, a few powerful logic and memory chips, a power supply, and a flat-panel display. All of these components, except for the Intel

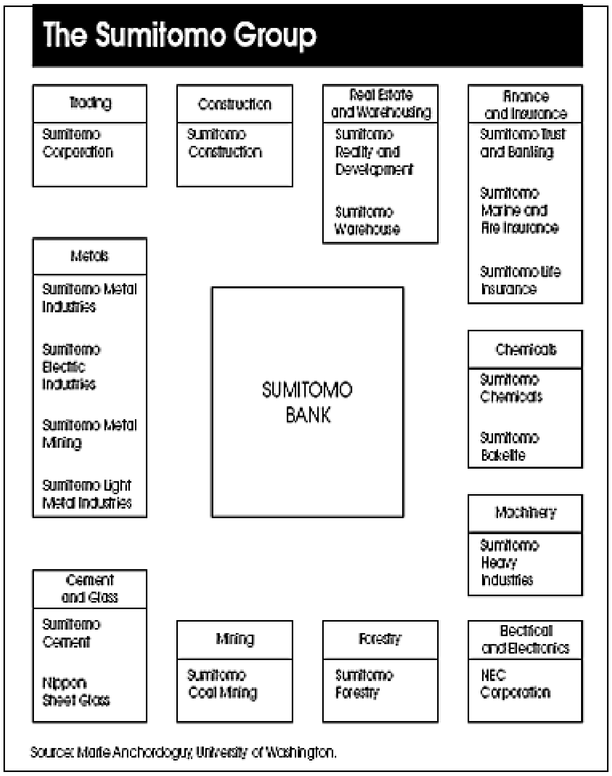
Profits are if anything lower for group members than for nongroup members, according to research by Nakatani Iwao, a professor of economics at Osaka University. Yet group companies as a whole have more stable growth and profit levels. This stability encourages investment in new technologies, such as semiconductors and biotechnology, and helps to keep out foreign products and investment. The companies often buy from each other and work jointly on R&D projects.

There are also strong buyer-supplier relationships among members of the same group. In 1987, trade between Mitsui's members accounted for 17.2% of the group's total trade; for the Sumitomo group the figure was 14.3%. The average of the six groups was 12. 7%. As of the late 1960s, about half of the computers that were used by companies in the major industrial groups were made by their keiretsu-partner computer company. This was at a time when Japanese-made computers were markedly inferior to foreign-made ones.

microprocessor, use nonproprietary, industry-standard architectures. Compaq makes none of them.

Conner Peripherals, a U.S. company based in California, makes the hard disk. Most of the other components are made in Japan, and those most critical to a laptop—the liquid-crystal display, power-management systems, and compact packaging—are made by Citizen Watch, a Japanese consumer electronics company. This situation is not unique to Compaq or to laptops. You would find much the same thing in any PC, workstation, server, or printer sold by Apple, Hewlett-Packard, or Sun Microsystems.

These systems exemplify several related technological and economic trends. Digital technology has improved at remarkable speed. The price/performance ratios of major digital technologies—such as microelectronics and photonics (that is, optical information technology)—improve 25% to 50% per year, a pace expected to continue for another 20 years. And as digital technology progresses, powerful and inexpensive personal systems, like PCs, are displacing expensive centralized systems, like mainframes. (This is true not only for computers but for all digital information systems—from pagers to fax machines—a point to which I'll return.) Although centralized systems will remain important, they will gradually become confined to specialized functions—coordinating networks,



The Sumitomo Group Source: Marie Anchordoguy, University of Washington.

Support of this kind enabled group computer companies to gain economies of scale and technological expertise. And group favoritism continues: most computers used by Sumitomo group companies today, for example, are from NEC, the group's computer maker.

Keiretsu exclude foreign companies from much of Japanese business, for example, by denying them acquisition of any Japanese company that could serve as an instrument of market entry. And yet they tend to intensify competition *within* Japan. There is a strong tendency for each group to follow the so-called "one set principle" *(wan setto shugi)*, that is, to have a company in each major industry—chemicals, electronics, construction, trade, mining, and so on. Thus Japan will have five or six well-backed competitors in most major industries, especially in those areas the government deems strategic.

managing central resources such as large data archives, and performing tasks that require enormous processing power.

The rise of mass-produced personal systems was the inevitable result of the arrival of Very Large Scale Integration (VLSI) in the late 1970s. VLSI made personal computing possible by permitting the development of powerful, one-chip microelectronic systems such as microprocessors, controllers, and large memories. The performance of single-chip systems improves more than 40% per year.

VLSI is one example of the fundamental trend in information technology. Future information systems will be constructed from increasingly powerful, mass-produced, inexpensive, small components: semiconductors, electronic packaging, circuit boards, disk drives, lasers, scanners, displays. PC microprocessors are produced by the tens of millions annually and are priced at about $100. The industries producing these components are coming to share a common cost structure and a similar kind of production: high R&D costs and capital-intensive, high-fixed-cost, high-volume, flexibly automated production aimed at lowering unit costs. More and more, competitive advantages go to companies with superior process technology and manufacturing.

If a company, domestic or foreign, introduces a successful product in a new field, it is likely that soon thereafter, four or five other well-backed companies will also enter the field. This practice is known as *kato kyoso,* or excessive competition, and tends to lead to overinvestment in capital equipment by private companies and often invites government intervention to manage investment, production, and prices through cartels.

Supply keiretsu, which usually branch off from the circle of principal group companies, serve a large manufacturer and are composed of several layers of subcontractors. They also usually have interlocking directorates. The principal manufacturer generally owns some of its subcontractors' stock and provides financial and technological assistance. This may well involve transfers of sophisticated new equipment or the training required to help the supplier produce next-generation products.

While members of bank-centered groups are generally considered equals, there is a clear hierarchical power relationship in the supply keiretsu. Manufacturers that head these groups often gain advantages by squeezing their suppliers, pressuring them to cut costs and deliver components for just-in-time production.

Supply keiretsu tend to be most developed in the auto, electronics, and machinery industries, where the product is composed of various parts. It is difficult to evaluate definitively the amount of intragroup trade in the supply keiretsu, but estimates suggest that it is at least as high as that in the bank keiretsu—say, 15%. This means that at least 30% (some researchers estimate 50%) of the business of member companies is done with

You can see this competitive transformation most clearly in the semiconductor industry. Only ten years ago, semiconductor production was dominated by successive generations of small-scale, artisanlike companies in Silicon Valley. Today most semiconductors are mass produced, and the world market is an oligopoly of huge companies, dominated by the Japanese industry. Six producers, four of them Japanese, hold more than 40% of the world semiconductor market. Since the mid-1970s, every technology generation has seen more than a doubling in the scale of R&D and capital investment required to compete. Technology progresses so rapidly that each generation lasts only about four years, and the useful life of capital equipment rarely exceeds five. Typically, each generation of R&D must begin at least five years before commercialization and must be coordinated with development of new capital equipment and materials, whose technologies are themselves becoming extremely complex and capital intensive. The industry grows 15% per year.

Any semiconductor maker aspiring to hold or gain market share must therefore spend enormous sums of money. Current technology requires, on average, $200 million to $1 billion for each generation of process development, $250 million to $400 million for each factory, and $10 million to $100 million for each major device design. These costs are expected to double again by the late 1990s, when the world semiconductor members of their groups. The groups consider foreign intrusion divisive, which explains the resistance to T. Boone Pickens's recent efforts to gain control of Koito, a member of Toyota's supply keiretsu.

Some will say Japan's keiretsu are a recipe for inefficiency: one would expect that suppliers, assured demand, would offer shoddy products at high prices and that member companies, assured of a bank bailout, would tend to become uncompetitive.

In fact, a long-used supplier will be terminated if the quality or prices of its goods become uncompetitive. Moreover, a group bank will not rescue a company deemed economically unviable over the long term, but it will help the company scale back its operations and diversify into more promising areas. The groups do support struggling companies in strategic industries such as computers, satellites, aerospace, and biotechnology. They have not had cause to regret such decisions.

market will exceed $100 billion.

Semiconductors are not alone in this regard: the trend toward high R&D costs and capital-intensive production is apparent in many components sectors. Within five years, for example, the cathode-ray tube displays in computers and televisions will be replaced by flat-panel, liquid-crystal displays (LCDs), with semiconductor control logic printed directly on the glass plates of the display; their resolution will surpass film-quality video. Laptop PCs, portable televisions, and pagers already use an early form of this technology. As in semiconductor production, the costs and performance of LCDs are determined by process technology parameters, capital equipment, and manufacturing yields.

The first generation of commercial-scale, flat-panel display factories are now being built. They cost from $100 million to $300 million each—and they all are in Japan.

Convergence: An Integrated Hardware Sector

There are other critical trends: the digitization of all information industries and their convergence into a single information hardware sector based on a common set of digital components technologies.

Consider the replacement of established technologies (optical, chemical, mechanical) by digital technology. Xerox's most sophisticated traditional photocopiers cost hundreds of thousands of dollars and produce about 135 copies per minute. They cannot perform image processing, accept electronic files, or communicate otherwise with computers. Laser printers, on the other hand, cost between $1,000 and $3,000 each, print five to ten pages per minute, and are fully programmable.

Using the same basic technology, Canon produces digital color photocopiers that already accept standard desktop publishing commands. Sharp has introduced a $25,000 desktop color fax machine—in Japan. (Xerox is now developing integrated, digital copier/printers that can be connected to networks. And though Xerox leads its Japanese competitors in software and systems architecture, its mass-production and components technologies lag behind those of Japanese companies.)

Similarly, Panasonic (Matsushita) recently introduced a fully digital VCR based on an erasable optical disk. Its technology is similar to that of CD players, CD-ROM data retrieval systems, and multimedia personal computers. Furthermore, the data transfer rate of these CD systems, 1.5 million bits per second, is virtually identical to the T1 standard for digital communication over the telephone network, so these systems will be able to operate over public networks.

In its relentless progress, digital technology is becoming the technology of choice for an ever-wider range of information products. Desktop publishing replaces mechanical printing, CDs replace vinyl records, digital fiber optics replaces analog telecommunications. Soon digital hardware will begin to replace traditional fax machines, cameras, and microfilm. The underlying technologies of printers, photocopiers, fax machines, telephone switches, computers, cameras, voice-mail systems, CD players, data archives, and televisions will soon be astonishingly similar. In some cases they already are.

Conventional (or analog) consumer and office products either cannot communicate at all or do so only very laboriously. When they are digitized, however, they can interact, using the universal language of digital information. They can be controlled through software and networked to computers and other digital systems.

The benefits of interactive, instantaneous cooperation between systems are enormous. With a combination of software and telecommunications, a snapshot taken with an electronic camera can be viewed on a PC display, processed electronically, archived on a mainframe, electronically mailed to coworkers, and then sent to a laser system for printing. Photocopying becomes one of many services available on a network. Copies can be customized via software commands and can be made directly from computer-generated files or electronically captured images as well as from conventional paper. And like computing tasks, photocopying requirements will be met largely by sending files over networks to personal laser systems, with high-performance "mainframe" systems reserved for high-volume, centralized reproduction tasks.

The process of digitization has economic consequences far beyond the replacement of one set of components and suppliers by another. All information industries and products *will become subject to the cost structures and general technological trajectory common to all digital products*—already evident in the computer industry. Competitive advantages resulting from control over earlier technologies—film, xerography, and so forth—will disappear. And because digital systems can interact, fundamentally new market demands will arise. The most important, probably, will be those related to networking, that is, to the standardization of hardware interfaces necessary for interaction between many products.

Market demand will therefore generate intense pressure on vendors to design and produce digital systems capable of cooperating with each other—which entails greater standardization. Users will want to connect systems that have different functions and are purchased from different vendors; they will also want to connect their own systems to those of other companies, individuals, and public networks. Unless products have standardized, industry-wide interfaces, integration will be prohibitively complex and expensive. The growing pressure for "open systems" already felt in the computer industry will therefore spread to imaging, printing, copying, and communications.

As new industries are digitized, we will see the evolution of a new competitive landscape.

Oligopolistic Components Industries. Minimum efficient scale for semiconductor producers is now more than $1 billion. Scale and scope economies for semiconductors, displays, lasers, and other components are growing even faster than the industries themselves. As a result, these industries are increasingly concentrated in the hands of large, diversified companies with access to patient capital. Moreover, with each new technology generation, innovative U.S. startups hold substantial world market shares—when the markets are small and price insensitive. As mass markets emerge, small startups are displaced by large companies with superior process technology, manufacturing capabilities, financial leverage, and global distribution channels.

Commoditization of Hardware. This is already visible in PC, workstation, and peripherals markets. The basis of competition is shifting away from unique functionality and toward price and performance, which are increasingly determined by the design, process technology, and manufacturing costs of components. Semiconductors and displays alone will account for more than half of the total cost of PCs and workstations now being designed for use in the mid-1990s. Standardized, mass-produced personal systems and peripherals already account for more than one-third of total computer industry shipments.

Digital systems will not become quite like traditional commodities such as soybeans or vinyl chloride. Rapid technological progress will continue. Innovative system architectures and products will continue to arise; architecture and design will remain important, even in mature markets. But the extreme market pressure on vendors to provide industry-standard interfaces will make it increasingly difficult for systems companies to maintain exclusive control over a proprietary design or customer base. This older strategy, one still used by companies such as Intel, LSI Logic, DEC, and Apple, will gradually become unsustainable. And although superior system design and architecture will still contribute significantly to price and performance, an increasing fraction of design decisions will be embedded in components. In fact, components producers will have more leverage than hollowed-out systems companies.

Components-Dominated Hardware Value Chain. Control of hardware markets is rapidly shifting upstream from traditional systems industries to makers of digital components such as semiconductors, displays, and electronic packaging. The new technological and economic circumstances are reversing the logic of vertical integration.

End-products companies are finding it difficult and expensive to integrate backward into components sectors. Siemens, for example, recently had to spend $1 billion to reenter DRAM production. Major producers of digital components and consumer products, however, can diversify and integrate forward into digital systems markets—as Canon, Sony, Citizen Watch, Matsushita, and others are now doing.

Canon, for example, already produces “notepad” PCs that recognize handwriting and electronic cameras that display images on personal computers and television sets. Canon also makes semiconductor capital equipment and personal laser printers (including all of those sold by Hewlett-

Packard and Apple). Similarly, Sony makes disk drives, televisions, and computer displays—including those used by Sun Microsystems and other U.S. companies—and uses these same technologies for its CD players, videodisk players, and PCs that retrieve text from CD-ROMs. Sony manufactures two million lasers per month for digital optical-storage products.

Playing to Japanese Strengths

This technology future plays directly to Japanese strengths. Diversified Japanese companies with strong digital technology bases and flexible production systems—Canon, Hitachi, Matsushita, NEC, Sharp, Sony, and Toshiba, for example—are able to make a variety of digital consumer, industrial, and office products. They dominate world markets for many standardized, high-volume products, including personal copiers, electronic and cellular telephones, fax machines, graphics displays, laser printers, and optical disk drives.

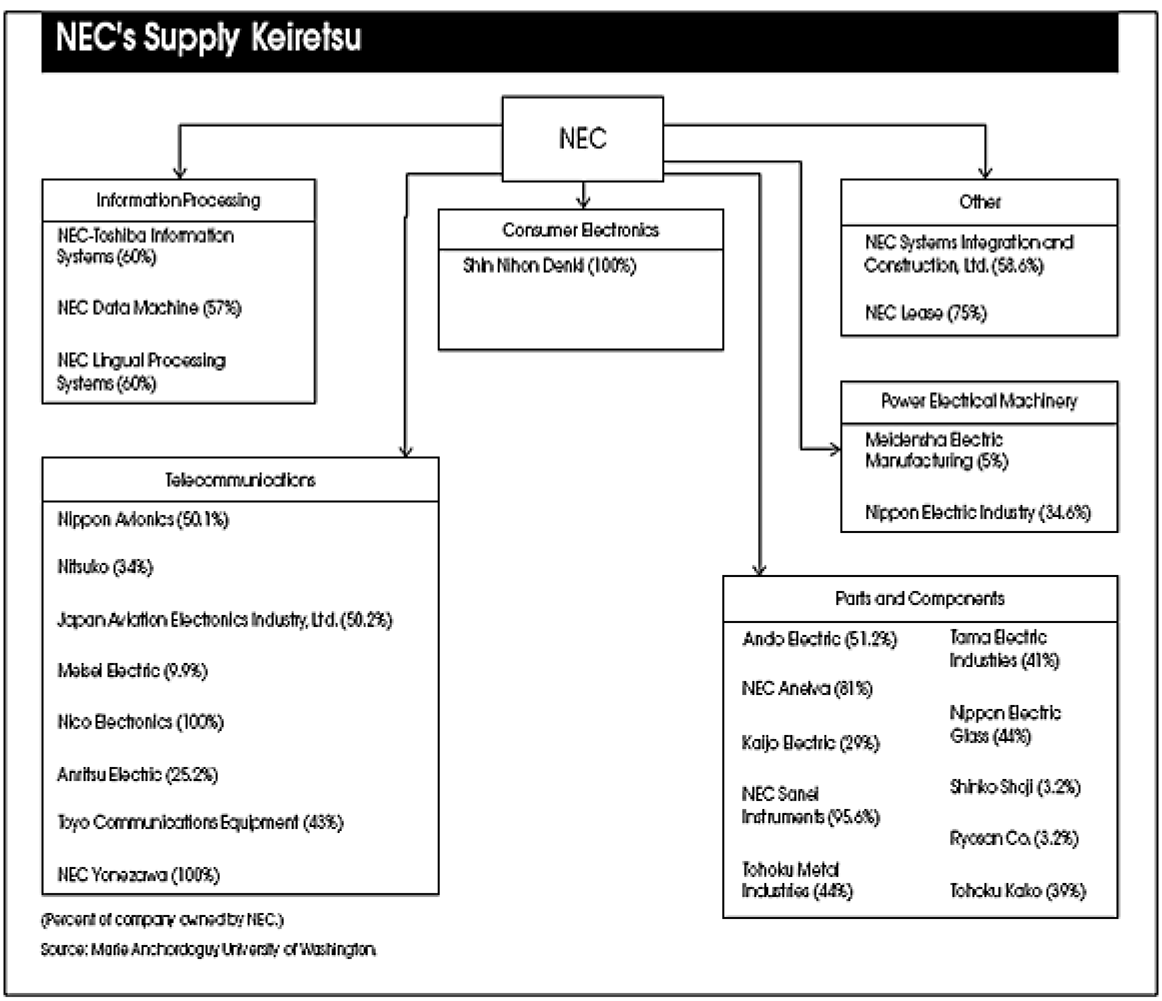
These Japanese companies are also leading components producers. Since 1980, the U.S. semiconductor industry's world market share fell from 60% to 35%, and it will probably fall to less than 30% by 1995. During the same period, Japan's share doubled to more than 50, and it continues to increase. Only in design-based markets, such as advanced microprocessors, do U.S. companies continue to lead, and even here U.S. primacy is eroding. The Japanese industry has tripled its share of world semiconductor capital-equipment markets, from 15% to 45%, and is approaching dominance of several critical equipment technologies.

Similar trends are taking shape in many new components and peripherals sectors, most strikingly in flat-panel displays. No U.S. company except IBM is technically competitive—and IBM's factory is in Japan. The same pattern increasingly holds for lasers, optical disks, electronic packaging, precision mechanical components, and printed circuit boards.

It should come as no surprise, then, that Japanese companies are entering more advanced markets for PCs, intelligent graphics terminals, engineering workstations, digital copiers, and high-performance storage systems. Their mastery of elaborate process technologies, components manufacturing, and flexibly automated product assembly has positioned them to dominate the whole value chain of information technology hardware. However, they also benefit from two industrial structures particularly fit for the new facts of competition: the diversified, integrated corporate complex and the keiretsu.

Corporate Complexes. The Japanese electronics industry is controlled by a small number of enormous, diversified, vertically integrated corporate complexes. Nine companies, with revenues ranging from $9 billion to $60 billion each, dominate the Japanese semiconductor, semiconductor equipment, computer, telecommunications equipment, imaging, office equipment, and consumer electronics sectors. Most of these companies also have close relationships with at least one of the six keiretsu that control 30% of all Japanese corporate assets and whose leadership includes the world's ten largest banks, the world's seven largest trading companies, and several of the world's largest insurance companies and securities firms.

Just as important, each major manufacturer leads a corporate complex that includes not only the parent company's divisions but also a network of subsidiaries, parts suppliers, subcontractors, and capital equipment suppliers. Both internal divisions and affiliates sell some of their output on a captive basis to the parent company, some to other major domestic companies (including direct competitors), and the rest to world markets. Linkages with these affiliates, some of which are themselves huge companies, are permanent, and they include personnel transfers, equity holdings, and technology relationships. (See the chart "NEC's Supply Keiretsu.")



NEC’s Supply Keiretsu Source: Marie Anchordoguy, University of Washington.

Consider some of the electronics holdings of the Sumitomo keiretsu banks. NEC, a $25 billion company that is the worldwide leader in semiconductor sales, is the Sumitomo group’s principal electronics company. The group’s lead banks, insurance companies, and trading companies own about 25% of NEC. However, they also own about 14% of Matsushita, a $50 billion electronics manufacturer, and roughly 9.5% of Pioneer, a $2 billion consumer electronics company. Pioneer’s other shareholders include Mitsubishi Bank, the lead bank of the $250 billion Mitsubishi group, which owns 5%; Fuji Bank, leader of the Fuyo group, which owns 4.8%; and the Tokai Bank, lead bank of the Tokai group, which owns 4.6%.

Vertical Linkages. These run several layers deep. Consider the Japanese semiconductor capital-equipment industry, on which nonintegrated U.S. semiconductor producers must increasingly depend. Lithography equipment production is dominated by Canon and Nikon, which together hold more than 60% of the world market. Canon is an $8 billion diversified electronics and imaging company in the Fuyo group; Nikon is in the Mitsubishi group. Sputtering equipment, another important but obscure sector, also is dominated by two companies—Materials Research Corporation (MRC), a U.S. company that was recently acquired by Sony, and Anelva. NEC controls Anelva, which supplies much of Intel’s sputtering equipment. NEC also owns 51% of Ando, one of the two principal Japanese suppliers of semiconductor test equipment. The other is Advantest, which is 25% owned by Fujitsu, a member of the DKB group.

Such patterns are endlessly repeated—in imaging systems and in the lasers and sensors in those systems, in computers and in the semiconductors and displays in those computers, in capital equipment and in the components and materials in that equipment, and so on.

The kereitsu system thus combines horizontal scale, diversified production of related systems, vertical technical coordination, and market discipline. Each sector—particularly critical components and capital equipment—is concentrated but not monopolistic, thus guaranteeing stability and scale while preserving internal rivalry. Each company’s production is partly but not wholly captive. Because products are dependent on the market, they are also disciplined by it—unlike wholly captive operations in vertically integrated U.S. companies, which often become complacent.

At the same time, Japanese producers have access to stable capital flows through both their parent companies and their banks. Thus they can absorb short-term losses and engage in comparatively risky, long-term R&D, thereby insulating themselves from the short-term financial pressures that plague U.S. companies.

Horizontal Coordination. Both parent and subsidiary companies maintain close, cooperative relationships with their major domestic competitors. They buy from and sell to each other, share technology, cooperate on R&D, operate joint ventures, have common banks and shareholders, and coordinate their dealings with foreign competitors. Few Americans, even those in the electronics industry, realize how deep these relationships are. For example, Matsushita is responsible for more than 20% of Japanese VCR production. Matsushita's principal domestic competitor is JVC, a consumer electronics producer whose VCR market share is slightly less than 20%. Yet JVC designs many of Matsushita's products, and Matsushita owns 51% of JVC.

This advantage is considerable. Japanese companies partition activities and then exchange results. They engage first in predatory pricing to eliminate rivals and then in cartelistic behavior to gain higher profits. They avoid excess rivalry in interaction with foreign competitors. They never poach each other's employees, and they buy preferentially from each other instead of from foreign or outside suppliers.

When U.S. companies with innovative technologies try to enter the Japanese market, they often find that their potential customers will not buy from them unless they are granted licensing rights. There is no need for the Japanese government to intervene to protect the domestic semiconductor market when six Japanese companies with deep, long-standing relationships account for more than 80% of Japanese computer production.

Japanese companies also compete with each other—sometimes quite fiercely, particularly in final-product markets. But for many reasons—their interlocking investments, their technological dependence on each other, and the strength of government industrial policy—their rivalry is restrained and subordinated to the larger goal of displacing foreign competitors. Thus the structure of Japanese industry gives rise to technological excellence and to predatory behavior; its extensive interlocking relationships facilitate both technological integration and strategic coordination against foreign rivals. It is a very powerful combination.

Dependence: The Present Danger

Japanese companies design and manufacture superb hardware and obtain much of their technology through legitimate effort. They have developed excellent engineering and mass-production capabilities. At the same time, they collude to force foreign competitors to license critical technologies, to block foreign applications for Japanese patents, and to deny foreign competitors access to technologies and markets over which Japanese industries gain control.

These attributes of Japanese industry are elements of a characteristically Japanese strategy for penetrating industrial markets. This strategy can be summarized as a progression from imitative, commodity, domestic components production to technology-based competition in world markets for final products. Japanese companies begin with foreign technology, progress to internal development of process technology, and then move to internal product development and basic R&D. As a result, the basis of Japanese competition shifts over time from cost and quality in commodities to cost/performance advantages based on superior process technology and engineering and then to superior product functionality.

In information technology, Japanese producers are moving from commodity components to system-critical components, from components to systems, and from low-priced consumer goods and "clones" to high-performance, high-value-added business and industrial products. (See the insert "How Japan Built a Computer Industry.") Meanwhile, U.S. and European semiconductor and systems companies are becoming dependent on their Japanese competitors for capital equipment, components, and OEM hardware. Japanese companies have proven that they will use this leverage to obtain design technology from U.S. innovators and to obtain competitive advantages in downstream market competition—for example, by preferentially supplying themselves with their superior components.

How Japan Built a Computer Industry by: Marie Anchordoguy

In the late 1950s, Japanese government officials recognized the strategic importance of computers: their overall impact on industrial productivity and their potential spillover into related industries

Take the case of DRAMs, the semiconductor memories used in computers and many other products. In 1985, following massive Japanese investments in DRAM R&D and production capacity, a wave of Japanese predatory pricing, and an industry recession, U.S. DRAM producers fell behind technologically and lost several billion like telecommunications. Over time, both government and business leaders recognized the computer industry as the *driver* of other strategic areas such as artificial intelligence and aerospace—that is, as an important industry in its own right.

The government employed four public-policy directives to nurture the industry from its embryonic beginnings to a competitive juggernaut: protectionist regulation, a computer rental company, cooperative R&D projects, and heavy subsidies. Though its power has waned in recent years, the Ministry of International Trade and Industry (MITI) has played a critical role in promoting computers.

In the early years, MITI's hand was heavy and crude. It imposed tariffs and arbitrary regulations to control foreign investment and imports. It pressured IBM to give Japanese companies access to basic patents at low rates in exchange for granting IBM permission to produce in Japan. MITI also controlled the type and volume of computers IBM produced and required the company to export a large proportion of its production.

IBM was then one of Japan's largest earners of foreign exchange. Yet the company was at the mercy of MITI bureaucrats. Strict control of foreign computers, matched with government procurement of some 20% to 25% of all Japanese-made computers, helped a domestic industry take root. Foreign market share plunged from a high of 93% in 1958 to 48% by 1965. Today it stands at about 35%.

While Japanese companies flourished under MITI's protective umbrella, it was clear to all that these same companies

dollars. By 1986, the leading Japanese electronics companies controlled 80% of the world DRAM market and held technological leadership over all U.S. producers except IBM.

Japanese producers then formed a cartel and regulated production, causing severe supply shortages in 1987 and extracting over $5 billion in excess profits from the U.S. computer industry from 1987 to late 1989. The Japanese industry simultaneously began to increase its share of the U.S. IBM-compatible PC market, selling PCs with large amounts of memory at very aggressive prices. During this time, Hewlett-Packard and Sun Microsystems also licensed their most advanced computer architectures to Hitachi and Fujitsu respectively.

IBM tried to license its DRAM technology to two major U.S. semiconductor producers in an attempt to break the Japanese cartel and strengthen the U.S. semiconductor industry. Both U.S. companies declined, and one entered into a major alliance with a Japanese producer shortly thereafter. IBM then agreed to license its DRAM technology to a proposed DRAM production consortium, U.S. Memories, which sought long-term investment from U.S. computer producers. Suddenly, world DRAM prices dropped rapidly. Then, in early 1990, U.S. Memories was abandoned because IBM and DEC were the only computer vendors willing to invest in it. One week later, six Japanese DRAM producers—who would be crushed if Japan opened its markets—as the government knew it would eventually have to do. The companies would have to be fully competitive with IBM, which meant offering rentals. So in 1961, MITI and seven computer companies established the Japan Electronic Computer Company (JECC), a computer rental company that bought systems from Japanese vendors and rented them to domestic companies at rates far below IBM's. Some $2 billion in low interest government loans were funneled into JECC between 1961 and 1981. JECC stimulated both the supply and demand for Japanese computers.

JECC paid computer companies up front—essentially an interest-free loan—enabling them to invest heavily in future models. In the 1960s, Japan's computer makers were losing money, and private banks were unwilling to lend more. JECC's up-front cash kept the industry alive. In fact, in the 1960s, JECC fed $270 million to the six makers, almost as much as the $289 million the computer makers invested in R&D and plant and equipment during that period. JECC also set computer prices and prohibited discounts. This forced the companies to compete not on price but on technology, quality, and manufacturing.

Japanese companies still faced enormous competitive disadvantages in production scale and technology during these years. Japanese computer makers' production volume was, on any given model, 1% to 2% that of IBM, and their technology was far inferior. MITI responded by sponsoring cooperative R&D projects: the labor was divided and the results pooled. In the early 1970s, the government gave money to Fujitsu and Hitachi to develop large computers, NEC and Toshiba to work on

are also Japan's largest computer producers—simultaneously announced production cuts and price increases.

World DRAM sales have risen from $1.5 billion in 1986 to more than $9 billion in 1989, and they are projected to be $10 billion or more in 1990. New Japanese DRAMs now appear in Japanese systems 6 to 12 months before they become available on the open market. At the same time, Japanese companies are rapidly increasing their systems production. Such leverage is not confined to DRAMs or computers. Recently, for example, a major Japanese supplier of LCD displays for Motorola's pagers announced its entry into the pager market. As U.S. components sectors decline, U.S. systems companies increasingly outsource components and hardware to vertically integrated Japanese competitors—and, predictably, face direct systems competition as well as pressure to license their designs to those competitors in order to ensure adequate component supplies.

This is not the only way Japanese companies harvest U.S. innovations. Japanese companies obtain designs by monitoring U.S. university research and standards organizations. About 20% of the members of MIT's Industrial Liaison Program, for example, are Japanese. Even more important, Japanese companies are beginning to make equity investments in U.S. startups. Canon owns 15% of NeXT. Fujitsu holds 30% of Poqet, a midsize machines, and Oki and Mitsubishi to work on small machines for specialized uses. No single Japanese company had the resources to develop a full line, but by dividing up the market temporarily, the industry as a whole was able to offer a product line as broad as IBM's offerings. Similarly, MITI tried to leapfrog IBM with the VLSI project, aimed at building the technology needed to make more densely integrated chips. To avoid redundant research, MITI had three groups try a total of seven different technological approaches.

From 1961 to 1981, the Japanese government put some $6 billion into the industry for R&D, new equipment, and working capital—a huge amount relative to what the companies themselves were investing. In the 1960s, it was 188% of the companies' investments; from 1970 to 1975, it was 169%; and from 1975 to 1981, 92%. The timing of aid has also been critical. Generally, it has come on the heels of an IBM announcement of a new computer.

It should be stressed that MITI has only partially protected Japan's computer makers from foreign competition and has actively encouraged domestic competition. JECC helped the companies rent their computers, but it only bought computers that users requested; it forced computer companies to be responsive to the market.

Finally, subsidized R&D was tied to performance. If a company failed to commercialize a project's results or became uncompetitive, it could expect to be excluded from the next project. And companies were pushed to do risky research they would otherwise have avoided (the VLSI project, for example).

new U.S. producer of handheld computers. Matsushita holds 52% of Solbourne, which produces Sun-compatible workstations. NKK just purchased 5% of Silicon Graphics. And a large Japanese company in the Fuyo group just purchased a major supplier to Sematech, the U.S. semiconductor R&D consortium.

A Natural Division of Labor?

Without imminent changes, U.S. and European vendors of information systems hardware risk becoming subordinate research, prototyping, and distribution arms for the Japanese industry's vertically integrated industrial complexes. Most observers agree that subordination would be catastrophic. But some, including conservative economists and executives in U.S. computer companies heavily dependent on Japanese manufacturers, argue that it is a natural, even desirable, development. Is it?

These analysts assert that the United States benefits from the normal progression of comparative advantage. According to this view, Japanese producers will specialize in commodity manufacturing, while U.S. companies will continue to lead by virtue of their command of the higher value-added activities of design, software, systems integration, and marketing.

The argument is appealing, but wrong–and not only because it ignores the strategic leverage of powerful Japanese suppliers. In the first place, the

The government helped the companies advance in this area but left them to compete in commercializing R&D and going to market. For every company there is a time to compete and a time to cooperate. That is the lesson worth learning.

hardware sector is too big. Hardware sales remain the largest source of revenue for large systems producers and also for the information technology sector as a whole. It is therefore simply impossible for U.S. services revenues to offset a rapid decline in the manufacturing sector, even if Japanese companies never entered services markets.

Second, the proposition that Japanese companies inherently fail in high-value-added design activities is spurious. Mercedes-Benz and BMW executives used to argue that no Japanese company could produce an acceptable luxury car. Since the introduction of Honda's Acura, Nissan's Infiniti, and Toyota's Lexus, they no longer make that argument. Even in digital electronics, the evidence is clear. In the early 1980s, LSI Logic, a startup in application-specific integrated circuits (ASICs), licensed its design software to Toshiba. VLSI Technology, another ASIC startup, licensed its technology to Hitachi. Japanese producers now hold 50% of the world ASIC market.

There is another argument. Systems-design skills will enable the United States to reconquer consumer markets as they are digitized. Presumably, Japanese companies will lose digitized consumer industries to superior U.S. computer companies. This is fantasy. Several consumer markets are already digitized—CDs, calculators, watches, and soon, audio tape—and nearly every one is dominated by Japan. Nor is it clear that continued U.S. leadership in design, software, services, and distribution will translate into a major advantage for U.S. or European hardware producers.

Design and services are more and more the bread and butter of relatively small, single-market companies with no allegiance to any specific hardware producer. Some computer retailers, value-added resellers, and systems integrators have even begun to favor Japanese hardware. Japanese companies already possess excellent distribution channels for video production equipment, printers, copiers, and fax machines. It is a relatively easy matter to create or purchase access to distribution channels. During the next few years, Japanese companies can be expected to make major direct investments in the U.S. distribution sector.

Searching for a Strategic Response

Some U.S. and European companies have made a conscious decision to cast their lot with Japanese industry. Others, such as Unisys and Wang Laboratories, have tried to delay the inevitable shift toward a more commoditized industry or have simply averted their eyes—with devastating results. However, a number of established companies, including IBM and Motorola, are preparing for the new world of standardized, mass-produced digital systems.

The internal operational reforms of these companies are largely similar and appropriate: reduced overheads, shorter cycles, cross-functional product teams, design for manufacturability. But in their strategic posture toward intellectual property, external technologies, standard architectures, and other issues, two exactly opposite approaches are evident: partnership on the one hand, ruthless, Darwinian individualism on the other.

Individualistic calculations predominate. Yet an increasing number of high-technology executives are coming to realize that winning at musical chairs gains you little if you are playing on the deck of the Titanic. IBM and a few European companies are leading the way, along with a growing number of smaller companies such as Lotus and Applied Materials and venture capital firms such as Kleiner Perkins Caulfield & Byers.

IBM has long been known as an extremely secretive, isolationist, and closed company. But despite its excessive bureaucracy, it is also the most farsighted and strategically sophisticated company in the U.S. computer industry. By the mid-1980s, IBM concluded that the U.S. components and capital-equipment sectors were in grave trouble. Its subsequent actions, particularly given the company's traditional style, have been extraordinary and exemplary. IBM played a leading role in the formation of Sematech. It has visited its U.S. competitors, presenting detailed assessments of U.S. and Japanese semiconductor technology. And it has increased its internal-components R&D spending to unprecedented levels and funded development efforts at Perkin-Elmer and other companies.

Indeed, IBM is the only U.S. company trying to both match Japanese technology and remain independent of Japanese strategic pressure; it is reportedly spending nearly $1 billion per year on semiconductor R&D. Recently, IBM inaugurated a $500 million building in East Fishkill, New York, devoted to advanced semiconductor technologies, including X-ray lithography. It is an extremely impressive facility, but it is also the only one in North America. There is a similar facility in Germany. There are about ten in Japan.

After the onset of the DRAM shortage in 1987, IBM offered to license its 4-megabit DRAM technology (whose development had cost nearly $1 billion) to major U.S. producers, sell DRAMs directly to some of its largest competitors (most declined), and license its DRAM technology to U.S. Memories. During the past several years, IBM has also taken minority equity positions in about a dozen U.S. software companies and licensed major architectures from several innovative startups, including NeXT and Silicon Graphics.

In addition, IBM offered to open its X-ray lithography R&D efforts to other U.S. companies, including competitors. Only Motorola accepted. It then announced a joint effort with Siemens to develop 64-megabit DRAMs, with development costs expected to reach $2 billion before the first commercial shipments begin in the late 1990s. When Perkin-Elmer announced that it would divest its semiconductor capital-equipment operations, IBM sponsored the transfer of the lithography operations to the Silicon Valley Group and the electron-beam operations to Eteq, a new venture funded by five strategic investors, including IBM and Du Pont.

The major European companies—Siemens, Philips, and Thomson—have behaved similarly. In addition to Siemens's reentry into DRAM markets, Philips has strengthened its semiconductor capital-equipment affiliate, ASM, and is building a semiconductor facility in Taiwan. SGS-Thomson was formed from the semiconductor operations of SGS, an Italian company, and Thomson-CSF, a French one. While U.S. industry contributed $100 million per year to Sematech, the Europeans formed a $5 billion consortium—JESSI—to restore European core competencies in microelectronics, semiconductor equipment, and computer-aided design. JESSI has approached U.S. companies and Sematech, requesting their cooperation. Other European cooperative efforts include Eureka, Esprit, and Race.

There is, however, a long way to go. Many companies, IBM and the Europeans included, continue to fall into overly individualistic patterns of behavior. Rather than seeking compromise and long-term strength through pooled resources, U.S. companies fight each other for narrow, short-term advantages and often duplicate each other's efforts. Currently, AT&T, the regional Bell telephone companies, U.S. equipment producers, and other interest groups such as cable operators and computer vendors—not to mention three sets of regulators—are deadlocked over telecommunications policy reforms. While Japan is rapidly developing both its telecommunications equipment industry and its advanced digital-telecommunications infrastructure, there is a real possibility that the U.S. telecommunications industry will simply stagnate.

This story recurs throughout the U.S. information technology sector. U.S. innovators, components producers, and capital equipment producers therefore consistently find that Japanese manufacturers are more willing than are U.S. companies to finance them, enter into partnerships with them, or invest in their R&D.

Indeed, several major U.S. semiconductor producers declined to produce new advanced microprocessors designed by Sun Microsystems and MIPS Computer Systems. Sun then went to Fujitsu and MIPS to NEC, and MIPS also sold 20% of its equity to another Japanese company, Kubota. Frustrated by a lack of interest from U.S. companies, a Stanford startup with an innovative DRAM architecture recently turned to Japan for funding. Likewise, several second-tier U.S. semiconductor producers continue to operate independently, despite widespread agreement that they cannot possibly reach efficient scale by themselves. As a result, they are inexorably falling behind their Japanese competitors in process technology. LSI Logic continues to compete with Motorola in advanced logic markets, for example, while both have become technologically dependent on their largest Japanese competitor, Toshiba.

Similarly, several U.S. companies possess excellent flat-panel display technologies. But they dare not spend the $100 million required for market entry without protection from Japanese predatory pricing. They need customer partnerships, but U.S. vendors have declined to cooperate.

Thus, despite many promising signals, U.S. companies too often go their own way. Even IBM cannot possibly survive alone. As for European companies, they are starting from behind and need U.S. partners for technical, strategic, and logistical support. Is there not a better way? The evidence suggests the need for a more conscious attempt to extend the efforts of IBM and others, that is, to create a more structured industrial response—a U.S. keiretsu.

Defensive Alliances and New Opportunities

U.S. companies need a high-technology strategy consisting of the following five objectives:

- To develop and continuously update a systematic, comprehensive analysis of U.S., European, Korean, and Japanese capabilities, activities, weaknesses, needs, and dependencies.

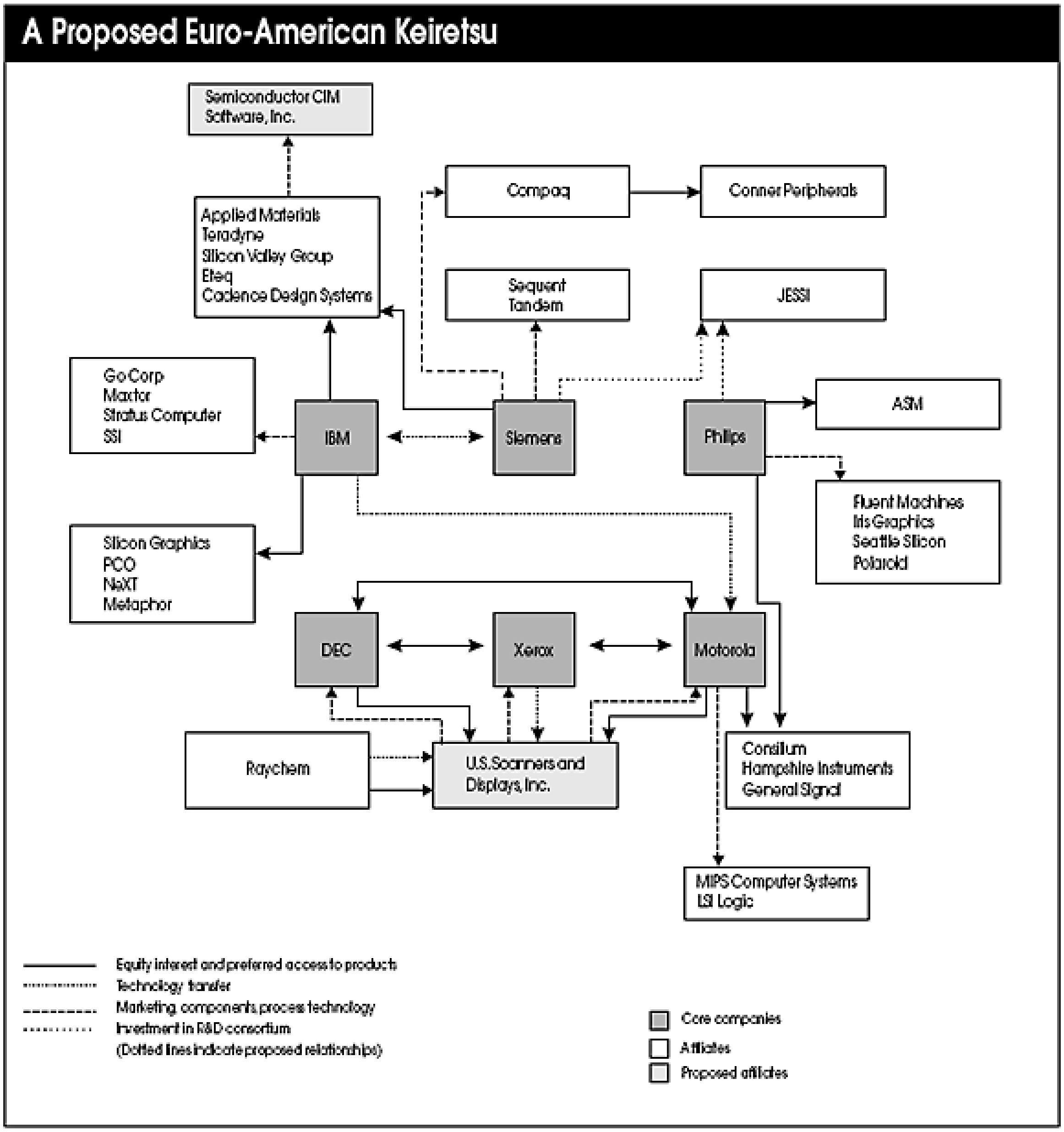
- To rationalize the U.S. components sector, enabling remaining U.S. and European producers to reach efficient scale, avoid redundant efforts, invest heavily in major technologies, and form long-term alliances.

- To make major investments and build alliances dedicated to preserving the technically competitive, non-Japanese components and capital-equipment supply base.

- To make strategic investments in novel designs and architectures and to share them preferentially in partnership arrangements with other European and U.S. companies.

- To assemble a political alliance enabling the entire U.S. information systems sector to agree on and pursue common policy goals that will end fragmentation and competition in politics as well as in markets.

Imagine a uniquely American or Euro-American variant of the Japanese keiretsu—one that exploits U.S. advantages in innovation, architecture, and design and that concentrates resources to reach competitive scale in components technologies and manufacturing. (See the chart "A Proposed Euro-American Keiretsu.").



A Proposed Euro-American Keiretsu

The core of such groups would be large, established companies: among them, IBM, Xerox, Motorola, DEC, Philips, and Siemens. These companies would create three sets of networks: vertical and cross-functional alliances with startups for technology development, vertical and cross-corporate alliances for components production and global marketing, and horizontal alliances for strategic leverage in dealings with the U.S. government and the Japanese industry.

Such alliances must differ from traditional vertical or horizontal combinations in several respects. Unlike conventional structures resulting from vertical integration, mergers, or acquisitions, these must preserve the entrepreneurship, market discipline, and flexibility of innovative companies. This means that large companies should make long-term, minority equity investments in smaller companies but should avoid the complete acquisition of them. Moreover, participating companies should avoid alliances based on essentially passive, reversible transactions.

Alliances should also entail technical and operational cooperation as well as financial transfers. They should establish strong linkages and incentives: interlocking, long-term equity linkages, ten-year stock options, personnel rotations, strategic control of licensing. One model alliance from the private sector is IBM's arrangement with Steve Chen's supercomputer startup, SSI. IBM has an equity interest, gains some control of technology rights, and makes available its basic technologies, while product design is left to SSI. It is ironic, bordering on tragic, that until the Bush adminstration removed Craig Fields as director of the Defense Advanced Research Projects Agency, Fields was experimenting with several such initiatives.

The impact of such investment alliances could be truly great if they were wedded to a clearly articulated strategic vision. Based on overall system needs, large companies could incubate new designs in startups, supply basic technologies, and then use their distribution and systems integration skills to commercialize new products. Thus they could form preferential relationships with "friendly" competitors and add-on suppliers, permitting open systems competition while retaining some control over the diffusion of new architectures and designs to purely imitative, manufacturing-based competitors.

Given U.S. leadership in the integration skills required for complex, heterogeneous networks, such architectural "umbrellas" could provide a uniquely American counterpart to the mix of cooperation and competition that serves Japan so well. It is well within the financial and strategic ability of the major U.S. and European technology companies to triple the flow of venture investing in advanced computer architecture, software, and innovative design systems. Moreover—and unlike conventional venture projects—financial flows could be integrated with the large sponsor's strategy and capabilities in base technologies, components, and global marketing.

Indeed, Japanese and Korean manufacturers have recently become interested in such arrangements. Traditionally, Japanese industry has avoided foreign acquisitions, preferring simply to license or copy foreign technologies. However, several large Japanese companies have established large venture-investment pools for acquiring intellectual property positions in new technologies and obtaining exclusive Asian distribution rights to new products.

Granted, such alliances imply a redefinition of competition. Rival companies can continue to compete, yet they should cooperate in the development of generic technology and components and through informal reciprocity in dealing with Japanese industry—much as IBM and Du Pont are doing in their joint investment in Eteq. U.S. Memories would have been an ambitious undertaking along these lines; its principal structural defect was the excessive number of participants it required. Small numbers work better. The equity linkages between Sybase and Lotus in database, networking, and applications software are far more promising.

The premature death of U.S. Memories should inspire concerned U.S. business leaders to think even bigger. Imagine competing U.S. designers of reduced instruction-set computing (RISC) machines, multiprocessors, and network architectures trading and sharing intellectual property rights to software or architectural components—while tacitly or explicitly denying imitative free riders from their circles of cooperation. They could also coordinate their purchases of Japanese commodity components such as DRAMs—for instance, through a trading company organized under the Webb-Pomerene Act, which insulates U.S. companies from some antitrust risks in dealing with foreign industries. U.S. companies would capture premiums in a standardized environment they themselves designed.

Such efforts can also yield powerful competitive advantages through their effects on the manufacturing supply base. If U.S. and European companies nurture and maintain a competitive technology base, they will be able to purchase from their Japanese competitors from a position of strength. And if they use their design, architecture, and software advantages strategically, they will be able to license Japanese process technology on reasonable terms.

One last point. To remain competitive, U.S. companies must, in the long run, harmonize their agendas with respect to government policy. Given the Bush administration's appalling record in technology, investment, and trade policy, and given the inevitable political strength of Japanese interests, it will be difficult under any circumstances to obtain reforms in areas such as intellectual property rights, dumping law, or telecommunications regulation. The Bush administration has shown some interest in antitrust reforms that will permit U.S. companies to cooperate in dealing with foreign competitors and will link antitrust violations by foreign industries to trade sanctions. Still, the industry can expect no significant government support until it speaks with one voice.

To some, these proposals will seem romantic, perhaps even xenophobic. They are neither. The technology trends are evident. So too is the growing technological power and strategic cohesion of the Japanese industry. Only by building appropriate corporate complexes will U.S. and European companies be able to secure their supply base against the strategic pressure exerted by integrated Japanese competitors and obtain sufficient financial returns from commercialization of innovative designs. Only by cooperating as they compete will U.S. companies be able to rationalize major components sectors, maintain a technically competitive, non-Japanese capital-equipment and components supply base, and create long-term, reciprocal partnerships between innovative designers, standards developers, large-scale manufacturers, suppliers, and distribution channels.

Digital technology and Japan's globalization are bringing a day of reckoning. American innovations have temporarily forestalled it, while making its arrival all the more inevitable. This day is at hand.

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