

Appendix A

Case Studies of U.S.-Japan Technology Linkages in Semiconductors

Several case studies of U.S.-Japan strategic alliances are presented here. A range of alliance types are examined, including a successful joint venture, an American start-up company that leveraged its semiconductor alliance with a Japanese partner to establish a strong market position in workstations, and a Japanese manufacturer that is employing alliances with U.S. start-ups as a key part of an overall diversification strategy.

CASE I: MOTOROLA-TOSHIBA

Since late 1986, the semiconductor alliance between Motorola and Toshiba has evolved in the direction of deeper interaction and a broader range of collaborative activity. The alliance is sometimes cited as an example of a U.S.-Japan linkage in which the technological benefits to the partners have been relatively evenly balanced. Although commitments to confidentiality by both sides necessitate a somewhat speculative treatment of the technology transfer mechanisms and impacts, the evolution of the relationship to date indicates that it has worked for both companies. The strategic orientation of the firms appears to hold out the promise of further mutually beneficial interaction in semiconductors and in other areas.

Historical Background: Motorola's Approach to the Japanese Semiconductor Market

From Motorola's viewpoint, the conclusion of its alliance with Toshiba should be seen in the context of the company's effort over several decades to gain access to the Japanese semiconductor market. From the late 1960s through the mid-1980s, Motorola shifted tactics a number of times in response to changes in Japanese government policy, market conditions, and lessons that it learned as a business organization.

In 1962, Motorola set up a sales office in Japan, but it soon became clear that this approach would not lead to significant participation in the Japanese market. At that time, Japan's formal trade barriers were substantial: the Ministry of International Trade and Industry (MITI) and the major electronics manufacturers tried to leverage protection of the domestic market and government-sponsored R&D programs in an effort to break the worldwide dominance of U.S. manufacturers in the semiconductor and computer industries. Although the success of this strategy became apparent a decade later, in 1970 the outcome was still in considerable doubt.

Motorola would have liked to set up a manufacturing facility in Japan to get around these trade barriers and participate in the rapidly growing Japanese market, which was led by the booming demand for televisions and hand-held calculators. However, Japanese government policy also restricted foreign direct investment. In order to manufacture, a joint venture with a Japanese partner had to be formed, with no more than 50 percent of the venture owned by the foreign entity. Motorola set up a joint venture with Alps Electric Co., Ltd., an electronic component maker with which it had previous dealings in other product lines. The joint venture, Alps-Motorola Semiconductor K.K. (AMSK), did back-end assembly and testing of devices, Japanese sales, and warehousing.

Motorola hoped that AMSK would evolve into a major Japanese supplier of its products. The venture ran into a number of difficulties and collapsed during the 1974–1975 industry recession. Besides the business climate, this failure may have been partly due to Motorola's inexperience in operating in Japan. The original joint venture agreement was not entirely explicit about spheres of authority, an omission that might not have made a difference in another setting but led to problems in Japan. Although the venture failed, those connected with it learned to appreciate the complexity of doing business in Japan, the value of making agreements with partners as explicit as possible, and the effort and care that would be necessary to have a chance at success. Motorola also learned that it was probably best to leave personnel and other administrative functions in the hands of Japanese partners while retaining authority over operational matters.

For several years, Motorola went back to operating a sales office as its primary presence in the Japanese semiconductor market. In the late 1970s, an engineering office was opened to establish closer relations with customers, and this office took on some testing and quality control functions. The sales force and most of the management were Japanese, yet market share was stuck at a low level. It came as no consolation that Motorola's American rivals, such as Texas Instruments, were also not doing very well in Japan. Around 1980, Motorola realized that the continuing growth of the Japanese industry necessitated another focused effort to gain access and to develop a manufacturing capability. A semiconductor company without a significant foothold in Japan would be missing a large chunk of the world market. In addition, Japanese customers were the most demanding in the world, and lessons learned from marketing in Japan could be applied to the benefit of global operations.

Motorola decided to try another joint venture, choosing Toko, Inc., as its partner. Toko was a small electronic component maker—primarily of parts for radios—that was not tightly bound to any of the large *keiretsu* groups. Most Japanese restrictions on wholly owned foreign subsidiaries were being lifted around 1980, so the decision to try another joint venture was based on the desire to overcome an outsider image that might hinder hiring and other local activities. Toko was "outside the loop" of relationships with MITI and large banks enjoyed by the major electronics companies, and was actively seeking an American partner. The interests of the two companies were complementary, and the alliance lasted for about two years, after which Motorola acquired the joint venture and renamed it Nippon Motorola.

The subsidiary does wafer fabrication and packaging for the Japanese market, and is also the world supplier of several Motorola products. Nippon Motorola made a major effort to meet the needs of the Japanese market, but progress was slow and difficult. Some marketing staff perceived that in a number of cases in the early 1980s, clients bought devices from Japanese companies after Nippon Motorola had done the application work.

Motorola also concluded several licensing agreements covering the 68000 series of microprocessors with Hitachi, Ltd. in the early 1980s, but this alliance ended in acrimony and lawsuits as Motorola and Hitachi accused each other of patent infringement. After a court decision that found fault on both sides, the companies reached a cross-licensing agreement.

Motivations and Negotiating Issues

In the mid-1980s, Motorola realized that it needed to change tactics again to strengthen its position in Japan. A partnership with a major Japanese electronics maker or trading company would give Motorola access to more of the Japanese market. Motorola's Japanese competitors had all become quite large, and large American companies with significant capability in microelectronics, such as RCA, seemed to be disappearing.

The decision to forge an alliance with a Japanese company was not taken lightly; some Motorola managers had hard feelings about past experiences in Japan. Yet by influencing Motorola toward a cautious, deliberate approach, this experience may have played a role in the eventual success of the Toshiba partnership. Before approaching any companies, Motorola evaluated possible Japanese partners by looking at both business and non-business factors: Toshiba rose to the top. Its partnerships with foreign companies had generally gone well, with both sides benefiting. It was judged that Toshiba could protect proprietary technology from other Japanese companies, and that Motorola could collaborate with Toshiba and not create a more serious competitor down the road. Some have asserted that the exchange of Motorola's microprocessor technology for Toshiba's DRAM design and manufacturing technology is the heart of the relationship. However, it is important to point out that Motorola, in initiating the negotiations, chose the partner that had a compatible culture and could provide the best market access.

For Toshiba, the partnership was attractive because of Motorola's leadership in microprocessors. Toshiba moved past NEC to become the leading Japanese maker of DRAMs in the mid-1980s, but it lagged behind NEC and Fujitsu in microprocessors. An alliance with Motorola giving Toshiba access to microprocessor technology would help redress that deficiency.

Talks between the two companies went on for more than a year and involved technical, business, and marketing personnel. The first element of the partnership announced in the press was an agreement for Motorola to purchase DRAM dice fabricated by Toshiba in August 1986. In December of the same year, the two companies announced an agreement to engage in negotiations to extend the relationship further.

The negotiations were conducted against the backdrop of a severe industry slump, particularly in DRAMs, and U.S. government antidumping actions against the Japanese semiconductor industry. The antidumping actions led to the conclusion of the U.S.-Japan Semiconductor Agreement in September 1986. Motorola had stopped making DRAMs in the United States for merchant sale at the end of 1985, as had all U.S. merchant companies except Texas Instruments and Micron Technologies. Although Motorola played a role in setting U.S. industry policy toward the U.S.-Japan semiconductor talks, the political atmosphere did not have a direct impact on negotiations with Toshiba.

Initial Structure of the Linkage and Technology Transfer

The basic elements of the partnership were set in laying the groundwork for the manufacturing joint venture, and reflected both Motorola's need for access to the Japanese market and Toshiba's desire for microprocessor technology. The agreement specified an equation whereby Toshiba would be given phased access to Motorola microprocessor know-how as Motorola reached given levels of market share in Japan. The market share measurement included all semiconductor product lines, not only the metal-oxide semiconductor (MOS) products manufactured by the joint venture facility.

There were a number of advantages to this form of agreement for Motorola. First, jointly building and managing a wafer fabrication facility committed both sides to a long-term investment of financial and human resources. Second, the arrangement contained built-in incentives for success beyond the desire to see a return on investment. To the extent that Motorola's Japanese sales rose, Toshiba would gain access to microprocessor know-how and the rights to utilize it. Both sides would suffer from a poor facility or if the personnel assigned to the partnership were not first rate. Third, by managing technology transfer within the framework of the joint venture, Motorola would have more control over the transfer process. Fourth, as an addition to the basic trade of technology for market access, Motorola would gain access to DRAMs manufactured at the facility, which it was no longer making in the United States, and could offer its customers a full product line. Finally, Motorola could access Toshiba's DRAM manufacturing know-how for use in its other fabrication facilities. The partners designated a site for the joint venture, Tohoku Semiconductor, in May 1987. The facility, which is located in Sendai, Miyagi Prefecture, was completed about a year later. Motorola began by transferring know-how concerning its 8-bit microprocessor, with an understanding that the technology transfer would be extended to its more advanced products as the sales milestones were hit. Although there were indications that the partnership hit some rough spots in 1988 and 1989, Motorola's sales in Japan increased markedly, especially at the beginning.

The microprocessor technology transferred to Toshiba through the alliance consists of circuit design and software operating codes. Toshiba became an original equipment manufacturer (OEM) for Motorola's 68020 microprocessor (a 32-bit product) in 1988. This agreement signified an upgrading of the relationship from licensing basic technology in phases and probably followed the achievement of one of Motorola's sales goals. In May 1989 the two companies agreed to expand cooperation at the Sendai facility to 4 megabit DRAMs. In June 1990 the two companies announced plans to codevelop a microprocessor for a new Toyota engine. That Motorola and Toshiba would be comfortable enough to work together on design indicates that a significant level of mutual trust had been established by that point.

The technological significance of the elements of the alliance related to memories is more difficult to evaluate. The strategies and capabilities of Japanese companies have, over the past decade, made the manufacture of DRAMs a "game" that depends on high capital investment expenditure in order to incorporate the latest developments in process technology and reach high volumes of production quickly. The firms that are ahead of the curve and can scale their production up quickly will attain lower unit costs than competitors. Motorola has been able to obtain access to a supply of DRAMs from Tohoku Semiconductor to fill out its product offering, and has been able to stay abreast of process technology improvements, which are driven by DRAMs, and to incorporate these in its other facilities.

Business Impacts and Future Prospects

The transfer of complementary technologies does not ensure benefits on the bottom line. The Motorola-Toshiba case is instructive because there are clearly areas in which both sides have benefited, but in other areas it appears that significant benefits have yet to materialize. The relationship is so complex that it is necessary to divide the consideration of impacts and future prospects into several parts.

1. Marketing Collaboration

Motorola appears to have made important progress in cracking the Japanese market since teaming with Toshiba, which was its basic goal (see [Table 14](#)). At the outset of the partnership, Toshiba had marketing objectives as well, but this element was not a major consideration and has not assumed importance since.

TABLE 14 Motorola's Semiconductor Sales in Japan (estimated)

Year	Amount (\$ million)	Change from Previous Year (%)
1984	106	NA
1985	73	-31
1986	113	55
1987	158	40
1988	273	73
1989	361	32
1990	436	21
1991	497	14

NOTE: Includes all products carrying the Motorola brand and sold in Japan, regardless of country of origin.

SOURCE: Motorola, Inc.

From the viewpoint of the U.S. industry, access to the Japanese semiconductor market has been an inherently political problem. Even after formal trade barriers were lifted, the established relationships between suppliers and manufacturers—some say involving informal understandings between the major firms to divide the labor in low-demand devices—have prevented U.S. firms with competitive products and prices from selling to auto makers, consumer electronics makers, and other major users of chips. The Toshiba partnership has worked for Motorola in overcoming some of these obstacles. The joint development of a microprocessor for Toyota is a good example. Both Toshiba and Toyota are members of the corporate group centered on Mitsui Bank (now Sakura Bank), and there is a large potential market for Motorola products among companies with which Toshiba has close relations.

Helping Motorola crack the Japanese market also helps Toshiba increase the U.S. semiconductor content of its own products and those of group companies; it can show the U.S. government that it is doing its best to reach the 20 percent foreign chip share targeted by the 1991 U.S.-Japan semiconductor agreement. Reports in the Japanese press that appeared in autumn 1991 indicate that the firms are planning to move to a higher level of marketing cooperation by mutually second sourcing their products, which should open up even more business for Motorola.

In 1990, Toshiba and Motorola agreed to collaborate on developing semiconductors relevant to high-definition television (HDTV). The history and implications of this particular part of the alliance illustrate the complex interplay among technological, business, and political motivations and benefits that may come to characterize a number of U.S.-Japan linkages in semiconductors and perhaps other industries.

The first report of Motorola's attempt to establish "design-in" relationships for HDTV chips came in May 1989 in the *Nihon Keizai Shimbun*. Motorola President George Fisher raised the issue on a trip to Tokyo with the director of the Machinery and Information Industries Bureau at MITI. The agreement with Toshiba to expand their relationship in this field came about a year later. Concrete results have yet to materialize, so discussion of the implications is necessarily somewhat speculative.

Although high definition television (HDTV) sets are still very expensive and the amount of broadcast time remains limited in Japan, the potential Japanese and world markets are huge even if Japan, the United States, and Europe adopt different standards. The benefits of establishing ground-floor supplier relationships with HDTV set manufacturers may prove to be significant for chip makers. Toshiba might also reap substantial benefits. Toshiba is generally considered to be behind some of its Japanese competitors, such as Matsushita and Sony, in advanced consumer electronics. Motorola may give Toshiba a boost as a key supplier.

The most significant potential benefits would come down the road in connection with the opening of the U.S. market to advanced television. Motorola may play an important role in developing microelectronics that implement whatever HDTV standard the U.S. Federal Communications Commission (FCC) finally decides on (in mid-1992). If Toshiba partners with Motorola to develop chips for sets directed at the U.S. market, it may gain a jump on its Japanese competitors, and will also gain politically by having higher U.S. components content. Both companies have complementary capabilities to influence the development of HDTV in the Japanese and American markets. To the extent that the market for HDTV or other memory-intensive intermediate products such as "improved" or "enhanced" definition systems grows in coming years, the demand for DRAMs will also grow, improving the prospects for that facet of the relationship (see item 3 below).

The ramifications of cooperation between Motorola and Toshiba in semiconductors for HDTV go beyond the two companies. In late 1991, some months after the Motorola-Toshiba collaboration in this area was announced, several similar consortia to develop HDTV chips were announced by Japanese companies. Each included at least one U.S. semiconductor company that had long-established linkages with Japanese partners. They were interpreted as being partly motivated by the Japanese government's desire to increase the share of foreign semiconductors sold in Japan in the face of the rapidly rising trade surplus. A Japanese press report on one of these consortia stated that the U.S. partner was not expected to contribute technically to the project but was recruited—perhaps at the suggestion of MITI—solely out of the need for an American name. Still, the final result is an interesting pattern in which Motorola identified a business opportunity, touched bases with MITI, and then negotiated an agreement with its Japanese partner. Subsequently, MITI and the major Japanese firms used the Motorola-Toshiba agreement as a model for similar design-in arrangements, partly for diplomatic reasons.

2. Microprocessors

Motorola has transferred technology to Toshiba connected with its 68000 series of microprocessors. Toshiba may be using this exposure to build more expertise in the microprocessor area but thus far has not made a great deal of progress in the market. As in the United States, the main competition in Japan is between Intel's X86 line (in the personal computer market) and the RISC microprocessors of Sun Microsystems and others (in engineering workstations and, increasingly, personal computers). Even in its own end products, Toshiba uses a variety of microprocessors. The Sun SPARC chip is used in Toshiba's laptops, and Toshiba has recently signed licensing agreements with Sun and IDT for their new designs.

This lack of success is related to the trouble Motorola has had in breaking Intel's dominance in the personal computer market. By most accounts a technically superb chip, the 68000 is used in the Apple Macintosh but in few other high-demand personal computers. Motorola's early efforts to license the 68000 to Hitachi and Philips/Signetics did not give it wide enough breadth, and the Hitachi license ended in a lawsuit, as mentioned earlier. Motorola microprocessors have enjoyed more acceptance in engineering workstations running the Unix operating system. The movement toward open systems, RISC, and other technical trends may give the microprocessor market more of a commodity character in coming years, in which case Motorola's failure to achieve a clear victory over Intel might not prove fatal in the long-term. However, it may leave Toshiba without significant short-term benefits to show from this aspect of the alliance.

3. DRAMs

The DRAM business requires the ability to invest—at great risk—large amounts in capital equipment as well as in developing superior technology. Motorola may derive significant benefits from exposure to Toshiba's production technology because it can put lessons learned at Tohoku Semiconductor to work in its U.S. and European fabrication facilities. This may allow it to leverage the huge investments necessary to stay in the DRAM manufacturing technology race. Motorola continues to make DRAMs in Europe, and press reports over the past year and a half have indicated that Motorola planned to reenter the DRAM business with a new fabrication facility in Texas, and that Toshiba and Motorola were planning to join forces to build a new European fab.

However, as of 1991, these plans appeared to have been put on hold—as were other DRAM ventures previously announced by various companies and consortia—because a long industry slump showed no sign of ending. Although there have been reports that leading DRAM makers, such as IBM and Toshiba, are focusing their efforts on launching the 16M DRAM earlier than the traditional DRAM product cycle would indicate, industry experts say that this is not occurring. Plans for a Motorola-Toshiba European fabrication facility have been canceled. It now appears that Toshiba, rather than build its own European fabrication facility or build one jointly with Motorola, will assemble and test devices fabricated at Motorola's European facility for the time being. Interestingly, there has been no announcement at this point that the Motorola-Toshiba venture will extend to the 16 megabit DRAM.

As in the case of microprocessors, circumstances beyond the control of the partners have led to less concrete benefit from the DRAM technology transfer than might have been expected at the outset. However, the firms can implement their individual and joint investment strategies when market conditions improve, as they undoubtedly will. In this way, they can spread

the considerable expense and risk presently attached to investment in DRAMs. In the meantime, Motorola obtains technological benefits, although these are difficult for outsiders to quantify. As in the marketing cooperation area, Toshiba will benefit politically and perhaps on its bottom line by teaming with Motorola in its bid to "Europeanize."

Implications

The Motorola-Toshiba alliance has had mixed results in some business areas, but the relationship exhibits a logic that extends beyond short-term business results. Ironically, it is not the heralded swap of microprocessors for DRAM technology that has brought the most significant benefits, but the marketing collaboration.

What of the future? Both firms are strategically sophisticated and long-term oriented. There are two areas in which this linkage may develop in interesting ways in coming years: complementary approaches to systems and the treatment of political issues.

One market that will probably grow in coming years is that resulting from the fusion of cellular telecommunications and portable computing. Motorola's technical strengths in the former—including efforts to develop a global cellular network linked by satellites—and Toshiba's in the latter point to promising possibilities for collaboration, but to date no agreements have been announced in this area.

As for future political implications, Michael Borrus sets forth one view of U.S.-Japan alliances, such as that of Motorola-Toshiba, by remarking that "there is a widely held belief that, through the relationships, U.S. firms can be made increasingly dependent on their Japanese partners for technology and markets to the point that U.S. firms sacrifice their autonomy of action."⁴¹

There may well be a long-term danger of this type for Motorola or other U.S. companies with close linkages to Japanese firms. The surprisingly accommodating stance displayed by the U.S. semiconductor industry during negotiation of the renewal of the U.S.-Japan Semiconductor Agreement in 1991 was seen as evidence of this dependence by some.⁴² For Motorola itself, however, autonomy of action does not appear to have been impaired. For example, Fisher's call on MITI concerning HDTV chips in 1989 came several months after the resolution of a contentious dispute in which the United States Trade Representative tangled with the Ministry of Posts and

⁴¹ Michael Borrus, "Chips of State," *Issues in Science and Technology*, Fall 1990, p. 46.

⁴² This may have been more the result of pressure from U.S. users than from Japanese partners; at the time of the negotiations, dumping had ceased and progress was discerned in overall U.S. design-ins and sales as indicative of long-term market share growth.

Telecommunications over cellular phone standards. The dispute was resolved in Motorola's favor. In 1990, Motorola received Japan Development Bank financing for the construction of

a completely Motorola-owned assembly and test facility in Sendai, the first 100 percent foreign capital firm to receive such loans. Also, in the autumn of 1991 the Japanese press reported that former Motorola chairman, and now chairman of SEMATECH Robert Galvin was the guiding force behind an effort to build cooperation between SEMATECH and the European microelectronics consortium JESSI—a move interpreted as being targeted at Japan.

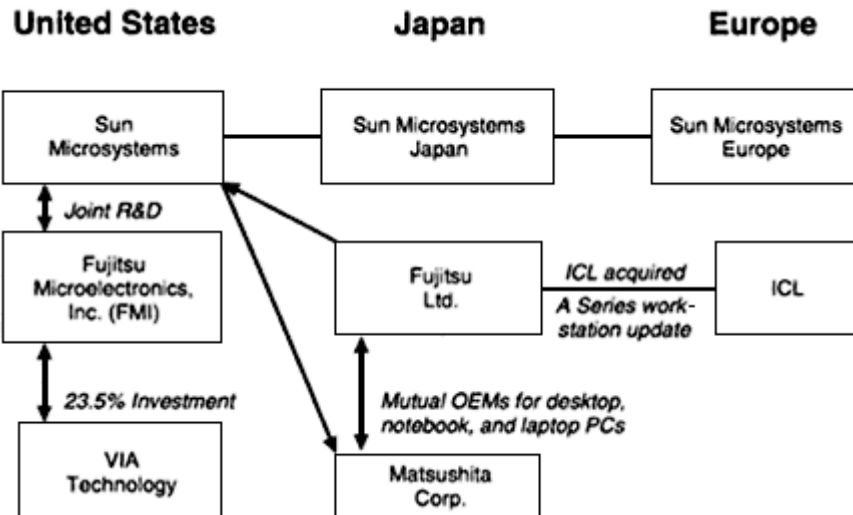
It appears that, thus far, Motorola is leveraging the marketing and political influence of its Japanese partners, Toshiba in particular, to increase its presence in Japan while retaining the independence to take positions critical of Japan when this serves corporate interests. A great deal of Motorola's leverage in its relationship with Toshiba undoubtedly stems from U.S. pressure on Japan to open its economy, in particular the semiconductor industry. It would not be in Motorola's best interests to lose this leverage by doing the bidding of the Japanese government in Washington.

A critical lesson of this linkage is the importance of persistence for U.S. companies. To reap the benefits from its relationship with Toshiba, Motorola has had to spend many years of building its presence in Japan, doing its homework, and knocking on doors that remained closed until fairly recently.

CASE II: SUN-FUJITSU

The alliance between Sun Microsystems and Fujitsu Microelectronics, Inc. (FMI), is an example of a successful U.S.-Japan computer/semiconductor company alliance that demonstrates how U.S. companies can leverage Japanese components, manufacturing, and distribution channels to establish worldwide market share. The Sun-Fujitsu strategic alliance has been crucial to Sun Microsystems' success in the highly competitive workstation market. FMI produces 32-bit RISC processors for Sun workstations based on Sun's SPARC (Scalable Processor ARChitecture) operating system and distributes Sun workstations throughout Asia. Fujitsu may also become a second source for SPARC-based laptop workstations, reducing Sun's current sourcing of Toshiba laptops.

The alliance has delivered benefits to both companies. It has established Sun as the leader in the fast-growing workstation industry. Sun achieved a half-billion dollars in sales in just five years and has captured nearly 25 percent of the Japanese workstation market. Without FMI's early commitment, Sun might not have distinguished itself as an industry leader. The alliance enabled FMI to enter the laptop workstation market. Among workstation users, SPARC has become a de facto industry standard. To



microprocessor lines since the SPARC would take them out of their mainstream business. Advanced Micro Devices, Fairchild, and Texas Instruments had technical solutions, but they were six to twelve months behind Sun's schedule. Fairchild had a 5-MIPS Clipper processor, but it was too slow. Thus, Sun could not find a suitable U.S. partner.

For their part, U.S. companies considered Sun's overtures too risky. Sun was an unknown start-up company among many potentially viable competitors. Although reduced instruction set computer (RISC) was attracting attention, it was an unproven commercial technology. Microprocessor vendors preferred to focus on their own complex instruction set computer (CISC) microprocessors.

In a last-ditch effort, Sun went to FMI's headquarters in Silicon Valley to secure a microprocessor manufacturer. According to Ken Katashiba, general manager of FMI, Sun's timing was fortuitous since FMI was seeking to invest in emerging technologies and growth companies. Katashiba felt that producing SPARC chips for Sun could position FMI in the high-growth technical workstation market. However, convincing Fujitsu's top management in Tokyo, which Katashiba described as having a "mainframe mentality," was difficult. However, executive vice president and director, Matami Yasufuku, founder of Fujitsu's semiconductor operations, liked Sun's proposal. FMI had a 20,000-gate array being considered by two minisupercomputer start-ups, Convex Computer and Alliant Computer, which were using FMI's 8,000-gate arrays. According to Sun's Bill Joy, "I don't think they [Fujitsu] spent days or months agonizing over it. That's perhaps my frustration with a lot of American companies. They spend so much time making up their minds that they miss the good opportunities. They don't act quickly enough."⁴³

After committing engineers to the task in 1984, FMI began producing S-16, a 10-MIPS SPARC microprocessor, for the Sun-4 workstation in 1985. Sun workstations became a hit in the marketplace, enabling it to take the lead worldwide with its Sun-4.

The Sun-Fujitsu alliance has evolved over time. In 1988, Sun FMI and Wind River signed an agreement to accelerate the use of SPARC in real-time computing markets. Fujitsu also signed a five-year agreement to market Sun workstations in Japan, which boosted Sun to the leading position, ahead of Sony Microsystems' NEWS workstations and Hewlett-Packard's machines. Table 15 contains a brief chronology of highlights in the Sun-Fujitsu alliance.

During this period, Sun had the opportunity to diversify its SPARC chip sourcing beyond FMI. Essentially, Sun had four options: (1) stay with

⁴³ Norm Alster, "How Intel add Motorola Missed the Sun Rise," *Electronic Business*, November, 1987.

ABLE 15 Evolution of the Sun-Fujitsu Alliance

Date	Joint Development Activity
1986	Fujitsu develops the S-16 SPARC central processing unit (CPU) for Sun workstations.
June 1988	Fujitsu, Sun, and Wind River Systems announce a cooperative R&D effort to accelerate use of SPARC architecture in real-time computing markets.
August 1988	Sun and Fujitsu sign a five-year OEM agreement valued at \$280 million. Fujitsu begins marketing Sun workstation servers (S family) for the Japanese market.
January 1991	Through its newly acquired British subsidiary, ICL, Fujitsu reconfigures its 68000-based "A series" around the SPARC chip and UNIX System V, Release 4 operating system.
May 1991	FMI develops two 32-bit RISC chip sets named SPARClite™ (MB869308, MB86940) based on SPARC architecture, which it began shipping in July 1991. These chips are targeted for the embedded control rather than the workstation market.

FMI, (2) make its own SPARC chips, (3) find a second source, or (4) establish a SPARC consortium. Table 16 lists the trade-offs of these options. Sun could manufacture its own chips—the classical "make or buy" decision—but semiconductor manufacturing is a totally different business that would require heavy upfront investments. Going it alone is a very risky strategy, especially because Sun had no semiconductor experience. Moreover, RISC is becoming a commodity market as more chip makers enter the market. Why didn't Sun choose a second source in the United States to reduce its dependence on Fujitsu? Sun could have found a second source, but it decided to stay with Fujitsu, which invested an additional \$280 million for a five-year exclusive distribution agreement in Asia. This is much more help than a U.S. chip maker could have offered. It gave Sun not only financing for next-generation SPARC development, but also access to the fast-growing Asian market. However, to reduce its dependency on Fujitsu, Sun has expanded its SPARC International consortium to 39 members. LSI Logic, ROSS Technology (Cypress subsidiary), Texas Instruments, and Weitek are U.S. members. This option gives Sun the advantage of building on the Fujitsu relationship, while consolidating its market position and diversifying its chip source.

Sun's alliance with FMI extends beyond Silicon Valley, where FMI's Advanced Products Division works closely with Sun to develop next-generation RISC processors. FMI owns 23 percent share of a start-up company, VIA Technologies, which is developing RISC processors for computer peripherals. In Europe, Fujitsu Ltd. recently acquired the British computer maker ICL, which will remodel Fujitsu's A series workstations using the SPARC operating system. Sun is not dependent solely on Fujitsu. Sun supplies workstations to Matsushita and Oki, which sell them under their own labels. Fujitsu and Matsushita have close computer ties. Toshiba uses the SPARC operating system for its laptop workstations. While these alliances put Japanese companies into the workstation market, they help Sun against its immediate competitors: Hewlett-Packard, IBM, Sony Microsystems, and MIPS Computer (ACE).

Sun is entering a variety of strategic alliances with Japanese companies to position its workstation in the Japanese market. Besides supplying SPARC workstations to Toshiba, Oki Electric, and Matsushita, Sun Microsystems Japan is working with Morisawa on font development and negotiating with the Taiwanese vendors Tatung and DTK Computer, which want to sell Sun-compatible workstations in Japan. Early in 1991, Sun began negotiating separately with Fujitsu, Toshiba, and Matsushita to develop the next-generation multimedia RISC workstations by using their digital video data base, video processing integrated circuits, video windowing, and integrated services digital network (ISDN) technologies. In addition, Sun has an extensive network of 2,000 value-added resellers (VARs) worldwide to promote hardware sales and software development agreements to develop applications packages.

TABLE 16 Potential Tradeoffs of Sun-Fujitsu Alliance for Sun

	Advantages	Disadvantages
FMI only	Reliability, stable source \$280 million deal	Dependence Potential competitor
Build chips	Control over technology Leverage over Fujitsu	Heavy investment No semiconductor know-how Unsure supply
Second source	Lower prices Leverage over Fujitsu	Administrative time Undercut Fujitsu alliance
Consortium	Lower prices Diversified chip supply Consolidate SPARC position	Administrative time Need to educate members

Since MIPS Computer announced its Advanced Computing Environment (ACE) consortium, Sun is expanding SPARC International. Table 17 lists Asian members of Sun's SPARC alliance.

Sun's strategic alliances are designed to improve its position in the Japanese market. The alliances range from RISC processor development (Fujitsu) and supply agreements (Toshiba, Oki, Matsushita, Tatung, DTK) to font development (Morisawa) and multimedia technologies (Fujitsu, Toshiba, Matsushita). The Sun-Fujitsu model provides the foundation for both these and the other SPARC alliances.

The Sun-Fujitsu alliance has created a "domino effect" among its VARs and end users, which have entered other alliances. Oki Electric, for example, uses Intel's 80860 microprocessor in its Oki Station 7300 workstation, which is supplied to U.S. minisupercomputer maker Alliant Computer. Toshiba, which supplies SPARC laptops to Sun, is planning to use the R4000 microprocessor from Sun's rival, MIPS Computer. Table 18 summarizes these activities.

The major impact of the Sun-Fujitsu alliance can be seen in the emergence of rival RISC computer consortia, as shown in Table 18. MIPS Computer, which completed a two-year exclusive agreement with NEC for its R3000 workstations, is working with ACE to compete with the Sun workstation standard.

TABLE 17 Sun's Japanese SPARC Alliances

Japanese Company	Joint Activity
Fujitsu Microelectronics, Inc. (FMI)	Responsible for developing and producing SPARC chips for Sun

Toshiba	Procures SPARC processor from Sun for its laptop workstation
Matsushita Computer Systems	Marketing Sun workstations under Systems its own brand name
Morisawa	Technical tie-up for workstation font development
Tatung-DTK Computer Japan	Sun negotiating over Japanese version of Sun operating system with both companies, which plan to ship Sun-compatible workstations
Fujitsu, Toshiba, Matsushita Electric	Sun negotiating separately with Japanese companies to develop multimedia workstation technologies for ISDN

TABLE 18 SPARC Workstation Alliances, 1991

Vendor	Partner	Agreement
Fujitsu	VIA Technologies	23.5% investment in VIA to develop RISC MPUs
Fujitsu	Sun Microsystems	Fujitsu produces SPARC chip, while Sun OEM supplies workstation to Fujitsu and Toshiba
Fujitsu	ICL	Developing SPARC-based UNIX workstation
Matsushita Corp.	VIA Technologies	4.7% investment in VIA to develop RISC MPUs
Matsushita Electric	Sun Microsystems	Sun OEM supplies workstations to Matsushita
Mitsubishi Electric	VIA Technologies	Owns 4.7% of VIA; distribution via Diasemicon Systems
Ok Electric	Sun Microsystems	Sun OEM supplies desktop workstations to Ok Electric
Ok Electric	Stardent Computer	Ok OEM supplies Ok Station 7300 workstation
Ok Electric	Alliant Computer	Ok OEM supplies Ok Station 7300 workstation
Toshiba	Sun Microsystems	Toshiba OEM supplying RISC laptops to Sun, while Sun OEM supplies desktop workstations to Toshiba
Toshiba	LSI Logic, Siemens	Planning to make R4000 for LSI Logic and Siemens
Toshiba	Unisys Japan	Supplying laptop workstations to Unisys Japan
Unisys Japan	Sun Microsystems	Sun OEM supplies desktop workstations to Unisys

ACE signals a trend toward global RISC workstation consortia. Recently, Hewlett-Packard licensed its Precision Architecture to Hitachi, Mitsubishi, and Samsung, which will supply workstations on an OEM basis to Hewlett-Packard. Intel Japan has teamed up with six companies in the United States and Japan to promote its i860 RISC processors. Motorola has the "88 OPEN" consortia for its 88000 RISC processor, and it will supply chips to IBM and Apple Computer for their RS/6000 workstations. In several years, all major workstation makers will belong to a RISC consortium. Sun has no choice but to expand beyond its Fujitsu alliance to SPARC International.

The significance of this shift from binational alliances to global consortia reflects the trend toward open computer architectures and more competition. Sun and MIPS Computer have successfully shown that by aggressively licensing their RISC technology to Japanese and other companies, they can establish their operating systems as industry standards. Fear of

losing sales to one's partner is greatly overshadowed by the fear of becoming obsolete in terms of industry standards. IBM, for example, recently dropped its go-it-alone strategy for its RS/6000 workstation, which has done poorly in the marketplace, and teamed up with Motorola and its potential rival Apple Computer. In personal computers, IBM has Matsushita manufacture its PS/2 and PS/55 in Malaysia. For U.S. workstation makers, the long-term risks of creating one's competitors is overshadowed by the more immediate threat of being eliminated altogether from the market. Although this is not an enviable choice, all major U.S. workstation vendors are pursuing a global consortium strategy to maintain competitiveness.

Thus, the computer industry is likely to see a proliferation of strategic alliances in the incipient R&D phase, which gradually expand into global consortia when the technology has carved out a market niche. U.S.-Japan alliances are becoming increasingly important because Japanese companies dominate many leading-edge technologies, such as LCDs, memory chips, IC cards, thin packaging, and mass manufacturing. The alternative for U.S. computer companies is not whether they should go it alone or team up only with U.S. companies, which may not have the critical components, but how best to take advantage of Japanese component strengths to expand their worldwide market share.

What are the lessons to be drawn from the Sun-Fujitsu alliance? The alliance demonstrates that it is possible for U.S. companies to leverage a Japanese partner into expanded worldwide market share. Although this dependence on Japanese companies may not be the ideal situation, it is clearly better than not being in business at all or remaining a minor player.

As Sun's Bill Joy admits, there is no such thing as a "free lunch." Fujitsu might become a competitor in the workstation market. In fact, Fujitsu has invested \$40 million in Hal Computer Systems, which is headed by an ex-IBM workstation manager, to develop a 64-bit superscalar microprocessor based on the SPARC architecture. For U.S. companies, there are always major trade-offs that must be considered when entering alliances with Japanese companies, as shown in Table 19. Only by considering these trade-offs can U.S. companies identify the long-term dangers. On the other hand, the Sun case demonstrates that remaining too conservative or slow-footed also means missing market opportunities. Fortunately, Japanese partners are no longer the only option for U.S. companies. The rise of global consortia may reduce U.S. dependence on Japanese alliances by broadening the sources of components, manufacturing, and distribution.

TABLE 19 Trade-offs of the Sun Microsystems-Fujitsu Alliance

Benefits	Costs
Access to engineering support	Potential loss of technology
Access to "patient money"	Vulnerable to outside pressure
Technology licensing to set standard	Create new competitors
Leverage partner's global organization	Time consuming and administrative costs
Access to manufacturing capacity	Loss of ability to manufacture
Joint marketing, sales, and distribution	Potential conflict over markets

However, the effectiveness of these consortia remains to be seen because they are difficult to coordinate and manage. Moreover, the decline in American competitiveness in critical components and the unwillingness of U.S. chip makers to divert from their mainstream businesses may still force U.S. computer makers to seek Japanese partners as a shortcut to global market success.

CASE III: KUBOTA COMPUTER

Kubota Computer is a classic example of a large Japanese company acquiring U.S. technology in order to diversify into high-growth markets. The heavy farm machinery company had been severely affected by the "yen shock" of 1986 and liberalization of agricultural imports. To offset stagnant and declining products, Kubota has systematically invested in a variety of emerging technologies critical to next-generation computers, ranging from workstations and minisupercomputers to magneto-optic disk drives and software, as shown in the Table 20. Kubota is following other Japanese steel and chemical companies that are quickly diversifying into high technology, including Asahi Chemical, Kobe Steel, Nippon Steel, Nippon Kokan, Kawasaki Steel, and others. However, what makes Kubota unique are the breadth and speed of its acquisitions.

In mid-1986, Kubota began by investing \$19 million in Ardent Computer, a minisupercomputer maker, which later merged with Stellar Computers to form Stardent Computers. Both Ardent and Stellar had leading-edge technologies but faced financial difficulties when sales were slower than expected. In exchange for a 22 percent equity share, Kubota agreed to market Stardent's TITAN minisupercomputers in Japan. Kubota also signed a contract to have Nippon Steel market the TITAN computer. The Kubota-Stardent partnership had four parts:

1. Kubota held a 22 percent equity share and had infused \$55 million after the merger.

TABLE 20 Kubota's Acquisitions and Investments

Company	Business	Date	Investment (\$ millions)	Share (%)
Stardent Computer	Minisupercomputers	7/86	19	22
		8/88	25	
		9/89	24	
MIPS Computer	RISC workstations	10/87	25	18
Akashic Memories	Thin-film media	12/87	16	100
		1/88	10	
Maxtor/Maxoptics	Magneto-optic drives	3/89	12	25
Rasna	Mechanical CAD and software	6/89	10	15
Exabyte	Computer magnetic storage	—	0	Board representation
C-Cube Microsystems	Image processing video compression	3/90	6.25	39.5
Teknocom	CAD software	1/91	0.23	37.5
Allied Information	Software	6/91	—	—
Tricord Systems	Computer servers	6/91	3.4	—

2. Kubota had sole marketing rights in the Pacific Rim.
3. Kubota did all manufacturing and set prices to Stardent.
4. Kubota had rights to all Stardent technology.

In essence, Stardent gave away its technology and high-growth Asian markets for continued existence as an R&D laboratory. In the autumn of 1991, Stardent closed down, wiping out Kubota's considerable investment.⁴⁴ Kubota Pacific Computer took over the TITAN line, Stardent's biggest operation.

At about the time the alliance with Stardent was launched, Kubota acquired 18 percent of MIPS Computer, a fast-growing RISC workstation maker in Silicon Valley. Kubota's goal is to resell MIPS workstations in

⁴⁴ William M. Bulkeley and Udayan Gupta, "Japanese Find U.S. High Tech a Risky Venture," *Wall Street Journal*, November 18, 1991, p. B1.

Japan and eventually develop its own proprietary workstations based on MIPS' R3000 and R4000 microprocessors. In 1990, newly created Kubota Computer and MIPS Computer jointly developed the RC6280, a minisupercomputer that runs the Unix operating system, a high-growth area in Japan. Kubota is supplying the workstation to MIPS Computer on an OEM basis. Kubota also has exclusive rights to manufacture and produce the MIPS RS3230 workstation in Japan. To achieve its sales goal of \$100 million, Kubota created an independent workstation department, organized a distribution network, and doubled its MIPS workstation sales and technical staff.

The Kubota-MIPS Computer relationship has deepened in recent years. In 1991, Kubota was commissioned by MIPS Computer to produce RISC workstations in order to reduce production and distribution costs and shorten delivery time for MIPS products in Japan and Asia. In mid-1990, Kubota joined MIPS' ACE consortium, whose members will develop advanced 64-bit RISC workstations based on the MIPS R4000 microprocessor.

In addition to computers, Kubota has invested in Akashic Memories (thin-film media), Maxtor/Maxoptics (magneto-optic disk drives), C-Cube Microsystems (image processing and video compression), Teknocom (CAD software), Rasna (mechanical CAD and analysis software), and Allied Information (software). Allied Information Systems, a merger of software firms Dynatech International, Applicationware Research, Conam, and World Business Wing, will enable Kubota and Allied to set up a distributed development system and establish regional R&D centers to hire university graduates in software programming. The emerging hardware and software technologies acquired through this diversification will position Kubota Computer in advanced workstation and minisupercomputer markets.

Like other foreign companies, Kubota hires U.S. attorneys, merger and acquisition experts, and management consultants to assist in identifying and negotiating its acquisitions and investments. Indeed, the large number of U.S. high-tech bankruptcies, lack of venture capital, and long payback periods have created a large market for "technology brokers" who sell off U.S. companies that are technologically rich but financially poor. This development is an extension of the large merger and acquisition activities of the 1980s but is a shift to high-technology assets and global buyers because the U.S. merger and acquisition market has declined sharply. Due to the overall computer industry slowdown and the insufficiency of U.S. venture capital, the selling of U.S. high-tech companies may accelerate during the 1990s.

What are the lessons of Kubota for U.S. companies? Japanese acquisitions are a mixed blessing. Besides giving away technology, they are vulnerable to lawsuits and management problems. In mid-1990, Kubota Computer became embroiled in a lawsuit alleging that Kubota had seized control of Stardent to secure its technology. Stardent fired its cochairmen, Allen Michels and Matthew Sanders, after they filed a \$25 million lawsuit. A

Kubota board director who investigated the suit also resigned. The lawsuit was complicated because of Kubota's contention that both cochairmen offered to resign from Stardent, sell their stock, and not bring any lawsuits in return for five-year consulting contracts worth \$3.5 million each. Kubota apparently rejected the offer. The lawsuit and Stardent's subsequent failure may have a chilling effect on Japanese investments and acquisitions in U.S. high-tech companies.

The failure of Stardent shows that investments in U.S. high-technology companies do not always pay off for Japanese companies, but Kubota's goals and expectations for its U.S. alliances go beyond short-term financial considerations. Alliances are designed to help Kubota build new technical competences in support of an integrated diversification strategy. Even when ventures fail, Kubota and other Japanese companies pursuing similar strategies retain the competence and ability to use the technology.