U.S.-Japan Technology Transfer: Accommodating Different Interests

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EXECUTIVE SUMMARY

. The years 1983 to 1984 included an intense and protracted debate in the U.S. over the renewal of the Export Administration Act of 1979, which proscribes export controls on technology transfer, primarily for national security purposes. Technology transfer to Japan was an issue, albeit relatively minor during this debate, because of the potential for diversion of sensitive technology to the Eastern Bloc. During this same period, technology transfer to Japan fueled the flames of another issue that was nowhere near being understood or resolved in 1980 or in the foreseeable future -- the technologic and economic threat of Japan. This paper addresses these and other technology transfer issues, options for U.S. policy, and the implications of pursuing some of the options.

. There are numerous stakeholders in many fields of technology transfer between the U.S. and Japan. This report cites examples relating to the transfer of computer and computer software technology, where the stakeholders range from the chief executive officer of a large computer firm in the United States to a small fledgling computer company in Japan, from Japan's Ministry of International Trade and Industry to the U.S. Department of Defense, from the U.S. Secretary of Commerce to the president of Nippon Telegraph and Telephone Corporation.

. Because of the multiplicity of interests affected, the U.S. policymaker faces two complex and fundamental issues regarding U.S.-Japan technology transfer. First, how can a satisfactory balance be achieved in policies and actions affecting or affected by technology transfer? Second, what should the U.S. response be to Japan's new strength as a competitor in high technology industries?

. U.S. and Japanese national interests are similar in many respects, but there are some important differences, such as Japan's homogeneity. U.S. and Japanese economic, national security, foreign policy, cultural, and scientific interests provide a useful context for evaluating the effectiveness of existing technology transfer policies as well as the implications of policy options. How well U.S. policies regarding technology transfer with Japan reflect these and other interests depends in part on how well the various business and government players in the U.S. and Japan are able to sort them out, relate them to their specific stakes of the moment, and think through the long-term implications for themselves and for the national interests. In addition, it will be necessary to execute these policies carefully to ensure that the national interests are maintained.

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The information base for this

paper ends August 31, 1984.

I. INTRODUCTION

Much has been said about Japanese management skills, including the fact that the source of most of Japan's management practices has been the United States. Relatively less is said about Japan's technological skills — the usual stereotype being that the Japanese are good at copying but not at innovating. But that inaccurate image of Japan's capabilities has been rapidly changing over the last decade, and it has been changing partly because of a new synergism catalyzed by many factors: Japanese management skills (largely imported from the U.S. and in some cases improved in practice), emerging technologies (transferred from the U.S. and Western Europe), successful economic strategies, and important cultural differences. This report deals with one of these factors, emerging technologies, and specifically examines U.S.-Japan technology transfer policies and issues.

Since this paper focuses primarily on the transfer of technology from the U.S. to Japan, it addresses some common issues associated with the transfer of technology from one advanced non-communist nation to another. Economic issues are in the forefront of this West-West technology transfer, given Japan's strong position in competing with the U.S. in certain sectors. This contrasts with West-East technology transfer where national security issues are primary if the technology that is being transferred can be used for military purposes.

To prevent U.S. technology from falling into the hands of the Soviet Bloc and thereby aiding its military build-up, the U.S. has enacted laws, established policies, published regulations, and coordinated with its allies to protect national and mutual security interests. Because the U.S. has been engaged in increased international

economic competition with Japan and Western Europe, there are those who think that the pursuit of economic interests, and specifically trading with the Soviet Bloc, could lead to fulfillment of Lenin's legendary dictum of the Western allies competing to sell the rope by which they will be hanged.

It should be clear that U.S.-Japan technology transfer can affect both economic and national security interests of the United States depending upon the particular technology and its uses. Later it will be shown that foreign policy and other interests may also need to be accommodated. One of the great strengths of a democracy may be its ability to ensure that many different interests are considered on any given issue. When it comes to a resolution of the issue, these interests are often considered and accommodated, and many are eventually reflected in the resulting policies of government or business. Another attribute of democratic government is the flexibility of the systems devised to carry out policies. As circumstances change over a period of time, these systems can often accommodate the new situations without a complete overhaul -- additions, a deletion or two, and a couple of changes here and there will suffice. These strengths will not help, however, if there is a lack of vision or foresight. Often it is useful to step back a little and assess how a particular issue reflects the current policies, actions, and forces emanating from government and business, and whether it is in consonance with evolving national interests.

This analysis attempts to help serve that purpose, namely to show the various interests involved in U.S.-Japan technology transfer that need to be accommodated.

A snapshot of the 1983-1984 timeframe. Although the issues involved in U.S.-Japan technology transfer consist of events, policies, and circumstances that have been brewing for many years, this report is primarily a snapshot of the situation during the 1983-1984 timeframe. To be more precise, the information base for this paper ends August 31, 1984. This is not to imply that all the isues were resolved then, let alone understood by all the players on both sides of the Pacific. The issues, policies, and circumstances have been very fluid and will continue to change.* In 1983-1984 the heat was turned up on West-East technology transfer issues during the protracted debate over the renewal of the Export Administration Act of 1979 which proscribes export controls on technology transfer. Technology transfer to Japan was an issue, albeit relatively minor, during this debate as this paper will show, because of the potential for diversion to the Eastern Bloc. During this same time, technology transfer to Japan fueled the flames of another issue that was far from being understood or resolved in 1984 or in the forseeable future -- the technologic and economic threat of Japan. This paper will explore this growing issue as well as several others.

Focusing the analysis. The objectives of this analysis are to: 1) select an example technology that is of growing importance and which

*Subsequent to the closure of the database for this report, there have been a few key events related to the issue referred to herein. For example, the Export Administration Act was renewed with some modifications in July 1985. Also, Japan's Ministry of International Trade and Industry announced in March 1985 the reversal of its stand on changes to software copyright protection laws in Japan, to the satisfaction of all parties. Nevertheless, the questions remain concerning how well the many interests are being accommodated under the latest changes in the rules of the game.

evokes significant technology transfer issues; 2) describe major technology transfer issues involving the U.S. and Japan; 3) present a representative cross section of players and their stakes in these issues; 4) tie these findings to the broader national interests; 5) present not only the U.S. perspective but also the Japanese and contrasting Western European (U.K., France, and West Germany) views; and 6) draw implications for U.S. government and business policies.

Japan is now recognized as a world leader in the research, development, and commercialization of several technologies, including ceramics, optics, machinery and others. This paper focuses on computer technology, and more specifically on computer software, the instructions that computer programmers write to tell a computer what they want the machine to do, because of its present importance and growing importance to both Japan and the U.S. The Appendix describes in more detail the importance of this technology. In computer technology, Japan is particularly strong in computer memory chip commercialization, but Japan is not considered, nor does it consider itself, a major leader in computer software technology. On the other hand, the U.S. is considered a major leader in computer hardware and computer software technology development and commercialization. Nevertheless, Japan has chosen computer software as one area in which to make major improvements in the future. The extent to which Japan depends on U.S.-originated computer software technology to improve its position affects U.S. scientific, technical, and economic interests directly. It can affect U.S. national security and foreign policy interests indirectly as will be pointed out later. As a result, U.S.-Japan technology transfer, involving even an area such as computer software, will have to be considered among the

many factors in the continuing debate on technology transfer and on the policies that govern the control and protection of technology.

A. DYNAMIC RULES OF THE TECHNOLOGY TRANSFER GAME

Scientific, technological, and mathematical innovations essential to the development of computers have been transferred between nations for centuries, and certainly before 1834 when Charles Babbage invented the first calculating machine. Since the appearance of the Mark I in 1944, the first successful general purpose computing system, computer development has accelerated greatly. Technology transfer made contributions to Japan's economic growth and resulted in Japan becoming a major factor in the computer world today. Concurrently, the transfer of technology to the Soviet Bloc has become an increasing concern. In 1965 IBM announced the S/360 series computer, and by 1972 the Soviets were able to display the first of the Ryad computers, essentially a functional equivalent of the IBM S/360 system.[1] Although the Ryad has been characterized as "backward by current Western and Japanese standards, the . . . [s]ystem is of considerable technological, political, and economic importance."[2]

Table A highlights the history of measures that facilitated or discouraged trade and the transfer of technology to and from the United States. The chronology reveals that these measures have swung back and forth from periods when technology transfer was tightly controlled to periods when trade and technology transfer were encouraged, even with the Soviet Bloc. Reflecting detente, trade and technology transfer was encouraged during the late 1960s and early 1970s.

> [Th]e initiative to liberalize export controls began to come from Congress [in the 1960s]. This resulted in the passage of the Export Administration Act of 1969 . . . .

> The new Act attempted to reconcile an encouragement of trade with the East with the maintenance of national security concerns by declaring it to be the policy of the United States both "to encourage trade with all countries with which we have diplomatic or trading relations" and "to restrict the export of goods and technology which could make a significant contribution to the military potential of any other nation . . . detrimental to the national security of the United States."[3]

Trade and technology transfer were more tightly controlled following the Soviet invasion of Afghanistan in 1979.

1940	Early export controls during World War II.
1942	Office of War Information Regulations on classification.
1946	Atomic Energy Act "born secret" Provision: All information about atomic energy classified at creation.
1949	Export Control Act requires examining exports to the Soviet bloc. Department of Commerce administers the act by means of Export Administration Regulations (EAR). Commodity Control List developed. Coordinating Committee for National Export Control (COCOM) organized. Three lists of controlled items maintained: munitions, atomic energy, dual-use items.
1951	Patent and Invention Secrecy Act requires Department of Defense review.
1952	Immigration and Naturalization Act covers visa controls.
1954	Mutual Security Act includes International Traffic in Arms Regulations (IATR) regarding export of military systems.
1969	Export Administration Act of 1969 reflects detente by encouraging trade with all countries.
1976	Arms Export Control Act of 1976. Report of the Defense Science Board Task Force on export of U.S. technology, commonly called the Bucy report, calls attention to the need to focus on design and manufacturing know-how rather than on product technology.
1979	Export Administration Act of 1979 changes the focus from goods to technology thus reflecting the Bucy report. Military-critical technology's list (MCTL) created.
1980	Public Cryptography Study Group (PCSG) recommends National Security Agency voluntary review of cryptographic works.

Sources: Adapted from National Academy of Science. Scientific Communication and National Security. Washington: National Academy Press, 1982, pp. 97-117; and U.S. Congress. Office of Technology Assessment. Technology and East-West Trade. Washington: GPO, 1979, pp. 112-126.

Table A

Chronology of Technology Transfer and Control Measures

1981	Department of Defense report on Soviet military power completed. Reagan administration views the criticality of technology transfer occurring in scientific exchanges. Administration cancels some U.S.-USSR bilateral exchanges. All validated export licenses with the USSR are suspended. The Administration at the first high level meeting of COCOM in 20 years asks for cooperation from allies in restricting technology transfer. National Security Council Technology Transfer Coordinating Committee is established where political, foreign policy, intelligence and enforcement elements are coordinated. Technology Transfer Intelligence Committee (TTIC) established by the director of Central Intelligence.
1982	Report on Soviet Acquisition of Western Technology published by CIA. National Academy of Science Panel on Scientific Communication and National Security, commonly called the Corson Committee, completes report recommending criteria for restrictions on university-related research.
1983	Export Administration Act of 1979 expires amidst heightened controversies over tightening or lessening of controls on technology transfer. Administration continues with regulatory mechanisms by executive order followed by Congress temporarily extending the Act. Hitachi, Ltd. and Fujitsu Limited of Japan sign separate secret agreements with IBM regarding computer software technology use. The United States and Japan sign agreement on the exchange of defense technologies. The United States liberalizes export control policy toward China.

Table A, continued

Contrasting transfer perspectives can be seen by comparing Table A, which primarily covers U.S. policies to control the flow of technology out of the country for national security purposes, with Table B, which shows the timetable of Japanese policies to control the flow of technology into their country for mostly economic purposes. (While Table B shows liberalization regarding quota restrictions, other trade barriers are not shown, such as tariffs and standards requirements.)

			Capital Liberalization (percent foreign ownership)		Liberalization of Import (no longer a quota item)
			50%	100%	
Calculator			Aug. 4, 1974	Dec. 1, 1975	April 19th, 1973
Computer	C P U		Aug. 4, 1974 (including IC for computers)	Dec. 1, 1975	Dec. 24th, 1975
	peripherals	memory + terminals			Dec. 24th, 1975
		others			Feb. 1st, 1972
	parts				Dec. 24th, 1975
Software			Dec. 1, 1974	Dec. 1, 1976	
IC	Number of components below 100		Aug. 4, 1971 (except IC for computers)	Dec. 1, 1974	Sept. 1st, 1970
	below 200				Apr. 19th, 1973
	over 200				Dec. 25th, 1974
Telecommunications			N.A.— Government Owned Monopoly		Jan. 1st, 1981 (date NTT permitted procurement of U.S. products)

*Note: These dates correspond to general nationwide policies. There are exceptions, most notably IBM Japan which started its post World War II operation in Japan in 1950 as a 100% daughter of IBM World Trade Company.

Source: Adapted from Welke, J.H. Data Processing in Japan. Amsterdam: North-Holland Publishing Co., 1982, p. 121.

Table B

Timetable of Liberalization of Japan's Computer and Telecommunications Industries

B. ACCOMMODATING DIFFERENT INTERESTS

The contrast between the Soviet military threat and the Japanese economic competition is reflected in the following quote from a February 1984 interview with Admiral B. R. Inman, President and Chief Executive Officer of Microelectronics and Computer Technology Corporation (MCC), and former Deputy Director of Central Intelligence:

> In the 16 years remaining in this century, we will worry about superpower confrontation and the general state of posterity. Too often, when one mentions superpower confrontation, we think in terms of the prospect for a nuclear weapons exchange between the U.S. and the Soviet Union. I think that this is the least likely challenge that we face in this century. Superpower confrontation is going to be both economic and military, and the players in the two games are different. The U.S. is the only country that will play in both these games.
>
> In the economic arena, the other superpower is certainly Japan. And watching that competition will be our principal adversary in the military arena -- the Soviet Union -- watching, unable to be a part of that great economic competition . . . .
>
> . . . [b]ut they [the Soviets] will also be looking very hard at what is the source of the cohesion of the [Western] alliance. Have they been held together by economic competition?[4]

While the Soviets and the Japanese present the U.S. with quite different challenges, it should be noted that the U.S. responses include technology transfer policies incorporated in the same legislation (e.g., the Export Administration Act of 1979) and carried out by the same agencies (e.g., the Departments of Commerce, Defense, and State). For the same legislation to reflect the many important interests in technology transfer or for any one agency to execute consistent policies requires significant political accommodation.

Computer hardware and software technology transfers between the United States and Japan encompass interests in primarily four areas:

economic, national security, foreign policy and political, and science and technology advancement. (See Chapters II and III.)

1. Economic Interests

Some U.S. business interests, or players in the economic competition with Japan, have been concerned that computers are or might be the next area where Japan will "target" its efforts following successes in textiles, steel, autos, consumer electronics, and other industries. The October 1981 announcement of the Japanese Fifth Generation Computer System project was interpreted by some as a signal that Japan is striving for a leadership position in the computer industry. But Japan had its own reasons for concern following the 1982 FBI sting operation and the 1983 settlement between IBM and Hitachi involving alleged theft of IBM trade secrets. Japan's leading computer maker, Fujitsu, also found it necessary to reach a settlement with IBM regarding the use of IBM software. Soon thereafter, Japan's Ministry of International Trade and Industry (MITI) proposed copyright legislation in Japan that would protect software for a considerably shorter time than in the U.S. Copyright protection of proprietary information for economic purposes can impede technology transfer. This contrasts with export controls for national security purposes, which are aimed at blocking the transfer of technology.

2. National Security Interests

Japan plays a role in the development and execution of policies that will prevent Western technology from flowing to the Soviet Bloc. Japan is by no means the major factor, but there is evidence that it is a target of the technology acquisition efforts by Soviet Bloc nations. In 1982, for example, Japan found it necessary to expel a Soviet

diplomat following alleged efforts at obtaining software technology. Nevertheless, there are those in the U.S. who think Japan has not done enough to protect critical technology. Japan is a member of the Coordinating Committee (COCOM), which was informally organized in 1949 to help control the flow of technology to Soviet Bloc nations.

3. Foreign Policy and Political Interests

Technology transfer has frequently been used as an instrument of foreign policy. Japan's present economic success is partly attributable to postwar U.S. efforts to establish a free and democratic Japan as a bulwark against Soviet expansion. The U.S. provided technology to Japan to ensure its economic vitality.

4. The Advancement of Science and Technology

An area that makes few headlines is that of the advancement of science and technology itself. But there is virtually a daily exchange of technology between the U.S. and Japan by means of open literature, conferences and symposia on computer hardware and software technology, new joint ventures, and defense coproduction contracts.

C. MAJOR ISSUES AND QUESTIONS

Sometimes actions taken on behalf of one of these interests may conflict with one or more of the others. A classic example is whether to permit U.S. companies to sell computers to a company in an allied country and risk letting the technology (embedded in the product) fall into Soviet hands. Japan's status as the U.S.' closest competitor in the worldwide computer and computer-related products industry naturally marks it as a target of concerted Soviet acquisition efforts. Japan is also an ally with whom the U.S. seeks to coordinate technology transfer policies with respect to the Soviet Bloc. Meanwhile, Japanese and U.S.

government and business interests continue to make significant technological advances, and Japan has begun to liberalize restrictions on the import of U.S. computer-related products. Technology transfer in general, and specifically computer software technology transfer, between the U.S. and Japan therefore raise the following issues and questions:

Issue 1. When is technology transfer in the national interest? When more than one U.S. national interest is involved, as is often the case in technology transfer between the U.S. and Japan, how should the U.S. prioritize or achieve the right balance among policies affecting technology transfer?

This issue of balance is illustrated by an excerpt from a 1983 memorandum from Richard D. DeLauer, Under Secretary for Research and Engineering, Department of Defense:

> [I]t is imperative that the Defense Dept. maintain a balanced perspective toward control of technology in relation to strengthening our technological base, to our armaments cooperation objectives with friendly and allied nations and to the health of our own industries.[5]

Question A. To what extent is technology transfer between the U.S. and Japan affected by or contributing to U.S. national economic interests?

1. Are the ground rules of economic competition, laws, policies, and regulations fair for both the U.S. and Japan? What affect do the rules have on technology transfer?

Some U.S. industry spokespersons believe that their industry has been unfairly targeted by Japanese government and industry. For example, Robert Price, President of Control Data Corporation, said in 1983 hearings in the Senate, "We don't have any problem competing with

the Japanese one-on-one with a company. What we have a problem competing with is the whole country."[6]

2. Does technology that is transferred receive fair value? If not, should U.S. companies raise the price or restrict access to their technology?

Many U.S. companies make their technology freely available. There have been only a few advocates of restricting Japan's access to U.S. advanced technology. In the computer industry, it appears that nearly all of the players are willing to let the market establish the price of the technology that is transferred.

3. Is there a sound basis for concluding that the U.S. computer industry will encounter the same kind of stiff competition from Japan as the steel, automobile, consumer electronics, integrated circuit, and other industries have? If so, to what extent is computer software technology transfer a factor? What are the best policies for meeting U.S. national economic interests/objectives: free flow of technology, collaboration, protectionism, or increased support for U.S. research and development efforts?

At the 1981 International Conference on Fifth Generation Computer Systems, T. Moto-Oka's opening remarks set the tone of Japan's new thrust in the computer industry:

> [W]e no longer need chase the more developed countries, but instead should begin to set goals of leadership and creativity in research and development and to pioneer the promotion of such a project throughout the world.[7]

4. Are there adequate proprietary software protections?

It may be difficult for U.S. companies to protect software in Japan because as at least one Japanese agency, the Ministry of International Trade and Industry (MITI), takes a view different than the U.S.

government and most U.S. companies regarding copyright protection for software:

> Programs are economic goods employed extensively for economic and business activities and are different in nature from work such as novels, art work, and music covered by the current copyright law.[8]

Question B. To what extent is technology transfer between the U.S. and Japan affected by or contributing to U.S. national security interests?

1. Does technology transfer contribute to U.S.-Japanese mutual security? In exchanges of defense technologies, what additional controls, if any, should there be against undesirable re-export or diversion to commercial uses?

In November 1983, the U.S. and Japan signed an agreement on the transfer of Japanese defense technologies to the U.S.[9] It is not yet clear how extensively this agreement might result in the reciprocal exchange of computer software technology. There have been many instances of technology transfer related to the defense of Japan.

2. Is the transfer of technology to adversaries being adequately controlled? To what extent is foreign availability a factor?

Some U.S. officials are troubled by Japan's ability to control the transfer of militarily critical technology.[10] There is also the concern that if U.S. businesses are restrained from providing technology to adversaries, other countries might be an alternate source.[11]

Question C. To what extent is technology transfer affected by or contributing to U.S.-Japan foreign policy and political objectives?

1. Is there sufficient U.S.-Japanese cooperation within the COCOM framework regarding technology transfer?

Observations of Japan's performance within COCOM indicate that Japan has been a cooperative ally; some U.S. officials characterize Japan's cooperation as equal to or better than other COCOM nations.[12] Nevertheless, concerns regarding Japan's control of its technology has prompted MITI to announce that it would be tightening its controls over possible technology leaks from Japan.[13]

2. Has technology transfer been in consonance with the various aspects -- such as economic, mutual security, political -- of U.S.-Japanese relations? Is it now?

While U.S. policy following World War II may have been to freely provide technology to Japan, by 1983 the U.S.-Japan Advisory Commission had agreed on a need to review the exchange of science and technology between the U.S. and Japan to "reflect the changing balance in the scientific and technological capabilities of the two countries."[14]

3. Are U.S. policies perceived clearly and consistently by Western Europe and Japan regarding technology transfer to the Soviet Bloc and China?

In 1983 a Congressional delegation learned that China will seek Japanese or Western European technology if the U.S. is not forthcoming with clear policy on the subject.[15]

4. Do the U.K., France, and West Germany consider U.S. and Japanese computer software technology and technology transfer policies a threat to Western Europe's economy and/or the NATO alliance?

In 1982 a U.K. Department of Industry Committee viewed Japan as a "major competitive threat."[16] The Fifth Generation Computer Project specifically prompted the U.K. to launch an effort to develop similar technology.

Question D. To what extent is software technology transfer between the U.S. and Japan affected by or contributing to the advancement of science and technology, or cultural and humanitarian objectives? Is there a consensus on what constitute the important computer software technologies? Are resources being focused on the most important areas?

Some business and science observers in the U.S. are concerned that this country does not focus its institutional, capital, and talent resources on the creation and diffusion of new technology. They note that MITI plays a major role in guiding and supporting technology acquisition, technology assimilation, and diffusion efforts in Japan. In the software area, MITI supports such efforts through various means including an Information-Technology Promotion Agency.[17]

Issue 2. Are the U.S. government and business communities adequately prepared to deal with issues affecting or affected by U.S.-Japan technology transfer now and in the future?

In 1983 several pieces of legislation were introduced in Congress that sought to redress the U.S. competitive position against Japan, particularly competitiveness in high technology and information-intensive industries. These include the Trade Reorganization Act of 1983, hearings on Japan's advances in supercomputers, and the Industrial Competitiveness Act.

There is one policy that appears to incite no controversy: It is generally believed that the U.S. must stay ahead in the technology race. But this goal is so fundamentally a part of the U.S. response to both the Soviet threat and the Japanese economic challenge that it may be taken for granted. If the U.S. does not invest in research and development to maintain its leadership position, it is believed that

there will no longer be technology the Soviets want to acquire, and Japan may supersede the U.S. in having the world's strongest economy. To offset this, the U.S. would have to do more than develop the technology; it would have to find ways to rapidly deploy that technology in weapon systems that will deter the Soviets, and ways to rapidly commercialize it in manufactured goods that are competitive with those of the Japanese.

D. SUMMARY

The United States has the major share of the worldwide computer hardware and software market and is considered by most industry observers to be the world's leader in computer software technology. But there are indications that Japan may some day be a formidable competitor, due in part to its applications of technology that originated in the U.S. U.S.-Japan technology transfer may evoke some of the same general interests (economic, national security, foreign policy, and the advancement of science and technology) as does controlling the flow of technology to the Soviet Bloc. There are obvious fundamental differences, however. The Soviets are not economic competitors; Japan is. The Soviets are a military threat; Japan is an ally. The U.S. foreign policy toward the Soviets has gone through periods of intense cold war, detente, and the present chill, while policy regarding Japan has by and large maintained a steady course from postwar reconstruction to today's high degree of mutual interests. While there have been sporadic periods of scientific exchanges with the Soviets, there has been a continual positive exchange with Japan. How well U.S. policies regarding technology transfer with Japan reflect these and other different interests depends in part on how well the various business and

government players in the U.S. and Japan are able to sort them out, relate them to their specific short-term stakes, and think through the long-term implications for national interests.

CHAPTER 1 NOTES

1. U.S. Congress. Office of Technology Assessment. Technology and East-West Trade. Washington: GPO, 1979, p. 233.

2. Davis, N.C. and S.E. Goodman. "The Soviet Bloc's Unified System of Computers," Computing Surveys 10 (June 1978):93.

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II. THE PLAYERS AND THEIR STAKES: DIFFERENT INTEREST GROUPS TRYING TO INFLUENCE THE OUTCOME OF THE TECHNOLOGY TRANSFER GAME

Historically, technology transfer policies have been influenced by larger national interests. As pointed out previously, the shifts in emphasis among national priorities over the years have resulted in shifts in technology transfer policies. (See especially Table A, Chapter I.) U.S. government technology transfer policies in the late 1940s and 1950s aimed at stemming the flow of technology to the U.S. cold war adversary, the Soviet Union. In the late 1960s Congressional initiatives together with the Nixon and Kissinger era of detente resulted in a noticeable change in technology transfer policies and increased trade with the Soviets. Although the dollar amounts were small compared to West-West trade, computers and other high technology products were sold to the Eastern Bloc nations for several years. Ever since the Russian invasion of Afghanistan in 1979, there has been a marked tightening of controls on technology transfer that has significantly affected the balance of policies.

Just as there has not been unanimity regarding national priorities, there has been none regarding technology transfer policies. Controversy over the right balance among technology transfer policies and actions persists -- witness the protracted debate throughout 1983 and 1984 in Congress over the renewal of the Export Administration Act.

A. STRIKING A BALANCE

This chapter examines the issues and questions outlined above and considers the roles and stakes of a number of players. The examples

relating to U.S.-Japan computer technology transfer are illustrative rather than definitive.

When is technology transfer in the national interest? When more than one U.S. national interest is involved, as is often the case in technology transfer between the U.S. and Japan, how should the U.S. prioritize, or achieve the right balance among policies affecting technology transfer?

Although many of the players refer to striking a "balance," the word seems to have a deeper meaning than some simple notion of equilibrium or equality of value. It has come to connote the process of government and business entities devising policies that politically accommodate their different interests in ways that are consistent with their perceived long-range objectives. The mere fact that there are different players with different interests suffices to breed considerable controversy, pressures and conflicting forces.

The dilemma of trying to achieve the right balance. Under the Export Administration Act, the Department of Commerce is responsible for the licensing of applications for the export of products and technology. On the one hand, the Department has the responsibility for promoting exports. On the other hand, it must ensure that critical technologies are not exported to U.S. adversaries. Some believe this presents a dilemma for the Department. One of its former officials said that the "Department simply cannot be expected to simultaneously administer export promotion and control policies."[1] The Commerce Department, other agencies, and businesses are often influenced by economic, national security, and various political interests that tug and pull their policies and actions in different directions.

The economic tug. The Association of Data Processing Service Organizations (ADAPSO) has 600 members who provide software packages, programming, and services. While ADAPSO strongly supports the goal of national security, it also contends that this goal should be achieved without harming the ability of U.S. firms to engage in business with U.S. allies.[2]

The national security pull. Within the Department of Defense there are divergent pulls on technology transfer policy. This is most evident when one contrasts the role of the Under Secretary for Research and Engineering with that of the Assistant Secretary of Defense for Policy. While the latter has been outspoken in calling for stricter controls on the transfer of technology, the former has expressed a need for a "balanced perspective toward control of technology in relation to strengthening our technological base, to our armaments cooperation objectives with friendly and allied nations and to the health of our own industries."[3]

The foreign policies arena. Effecting technology transfer policies domestically is difficult enough; accomplishing multilateral controls greatly complicates the matter. The Coordinating Committee (COCOM) has been able to agree on the control of certain export items, but the control of computer products and technology has eluded consensus. In 1982, the GAO reported that in a previous COCOM review, no agreement was reached on computers and numerically controlled production equipment.[4] In July 1984 it was reported that an agreement in principle had finally been achieved, but the details had yet to be worked out.[5]

Scientific and academic concerns. The scientific and academic community stakeholders are very concerned about these policy develop-

ments because technology transfer is a fundamental means to the advancement of science and technology. Technological breakthroughs not only stimulate further research and participation in certain fields, but often generate the revenue that supports research institutions. The community is worried that efforts to control technology transfer in the university setting (i.e., the circumscription of attendance or published material) will weaken the U.S. position in the long run compared with its economic competitors and adversaries and will not serve the overall national interest.[6] The academic community is also concerned about any national security policies that would exclude foreign nationals from areas of science and technology since these students compose a large percentage of the university population.[7]

A closer look at the economic, national security, foreign policy, and scientific areas will indicate who some of the stakeholders are, what roles they play, and why they are concerned about technology transfer policies accommodating their interests.

1. Affecting and Being Affected by National Economic Interests

Economic tugs on policy and actions are not all in the direction of free trade and free flow of technology. There are also major tugs in the direction of control because of the highly competitive nature of the economic game.

a. The economic competition and the rules of the game. Japan's economic competition with the U.S. has often followed a familiar pattern. Japanese firms, sometimes with government guidance, enter into an industrial area where they have not been strong, acquire U.S. technology, swiftly gain competence, and soon become major competitors. This process of protecting fledgling industries by carefully nurturing

and improving their technologies before submitting them to head-to-head competition has often been called "targeting." A series of competitive encounters with Japan has revealed this pattern of targeting and raises the following question: Are the ground rules of economic competition, laws, policies, and regulations fair to both the U.S. and Japan? What effect do the rules have on technology transfer?

Some U.S. computer manufacturers have claimed that they are targeted, making it difficult for them to compete in the Japanese market.[8] They contend that the inability to compete in Japan's domestic market creates an unfavorable international competitive position for U.S. manufacturers.

In an interview with this researcher, John Lacey, Executive Vice President for Technology and Planning, Control Data Corporation, described "two approaches" that a company can take in light of this targeting process. It can ask the government to speak for U.S. companies

> and some of that is necessary because there is a limit to what individual companies can do. But there is a lot that industry can do for itself, and one of the things is to minimize duplication in technology development and cooperatively derive it . . . take a leaf out of the Japanese book, but do it in a private sector environment rather than in a government led environment.[9]

Although some observers now see a trend in Japan to remove trade barriers in certain industries, there has been a history of barriers that have affected penetration of communications and information industries. In 1982 there were extensive studies conducted by the Office of the United States Trade Representative into Japanese barriers to U.S. trade and Japanese government initiatives to remove those barriers. The impetus to this study were charges by U.S. exporters that

Japan had erected these barriers to minimize penetration of the Japanese market by U.S. companies. Table C contains examples of trade barriers to telecommunications, data, and information services existing in Japan at that time.

Description of Action	Supplemental Details	Explanation
Discriminatory standards and requirements	Incompatible software standards	
Subsidies -- direct and indirect	Government subsidy of DP industry	Protection of government-provided DCS; (NTT) foster local industry through government (MITI) and NTT participation in R&D

Source: Office of the U.S. Trade Representative, Trans National Data Report 6 (October 25, 1982): 323.

Table C

Japanese Trade Barriers to Telecommunications, Data, and Information Services Industries

History sometimes seems to repeat itself. The 1970s and 1980s was not the first era that saw the Japanese telecommunications market closed to foreigners as long as Japan had the technology it needed. As Neil W. Davis writes:

> Largely built by British specialists under the direction of one George Gilbert, Japan's first telegraph line, from Tokyo to Yokohama, was opened in 1869 and within five years the Kyushu to Hokkaido line was finished. By the mid-1880's, the various foreign experts were all given their walking papers, and until 1981 the telecommunications arena with

> brief exceptions was all but closed to foreigners. Things are finally changing, but the more they change the more they stay the same.[10]

Japanese barriers to trade include a number of measures that restrict trade in Japan's telecommunications, data, and information service markets.[11] One of the potentially most lucrative markets in Japan is selling to the Nippon Telegraph and Telephone Public Corporation (NTT), a government monopoly. At stake is the $3 billion worth of telecommunications equipment that NTT purchases annually.[12]

The Post, Telephone, and Telegraph Administrations (PTTs) in Western Europe and Japan are government monopolies that have a history of closing off their markets.[13] Although NTT officially opened its procurement doors to foreign suppliers in January 1981, there are those in the U.S. who think that too few purchases have been allowed. In contrast, the opening of the U.S. telecommunications market was initiated by the divestiture of AT&T in January 1984. Increasing sales from foreign suppliers have established a trend toward a more open market in the U.S.

Computer software has been one of the areas in which NTT has decided to make procurements. In 1983 it was announced that NTT had decided to purchase approximately $4.4 million in computer software from the U.S. — a sign that NTT restrictions on the purchase of software technology and products may be easing.[14]

b. <u>How free and open should one be with technology from the standpoint of economic interests</u>? Not too long ago, it was common to see Japanese business visitors touring U.S. businesses to learn modern U.S. methods. But since the Japanese have become formidable economic competitors, they are not as welcome to tour U.S. business premises,

especially computer companies. IBM has taken strong actions to protect proprietary data, especially from exploitation by the Japanese. AT&T, a new player in the computer market, has been relatively more open with its technology, both domestically and internationally, possibly hoping to fuel a successful entry into the computer market.[15]

These strategies and views raise the questions: Does technology that is transferred receive fair value? If not, should U.S. companies raise the price or restrict access to their technology?

c. Are policies consistent with the perceived competitive threat? The Japanese announced the initiation of their Fifth Generation Computer Project at the International Conference on Fifth Generation Computer Systems held in Tokyo in 1981. Since the project would focus on the area of artificial intelligence, the U.S. artificial intelligence (AI) community reacted strongly. One AI proponent in the U.S. expressed the view that we could not sit by idly for we were "squandering our lead" in this area to Japan "at the rate of one day per day."[16] The tone of Japan's Fifth Generation project announcement and exploitations to achieve world "leadership" in AI helped to intensify the competition.[17]

The fact that some U.S. observers fear that the U.S. is in danger of losing its lead in AI, and some in Japan see AI as a means to technological leadership, does not necessarily mean that a crisis is at hand. After all, as one observer put it, in 1958 founding members of the AI movement were promising near miracles in the "visible future."[18] And as this observer now notes, "the most recent ambitions of the Japanese were already close to being realized according to leaders of the American artificial intelligence community a quarter of a century ago!"

Nevertheless, observers in many sectors of the U.S. computer industry wondered whether this was going to be another serious challenge from Japan. Is there a sound basis for concluding that the U.S. computer industry will encounter the same kind of stiff competition from Japan as the steel, automobile, consumer electronics, and integrated circuit industries have? If so, to what extent is software technology transfer a factor? What are the best policies for meeting U.S. national economic interests/objectives: free flow of technology, collaboration, protectionism, or increased support for U.S. research and development efforts?

Reaction to the Japanese challenge in computer technology came from many sectors and stakeholders in the U.S. It was not long before some officials in the U.S. Department of Defense expressed concern that "we don't want the Japanese to take our ideas and run with them as they did on their Fifth Generation Computer Program."[19] This concern was heightened with publication of trade imbalance figures by the Department of Commerce, along with further Commerce statistics that indicated that the U.S. leadership in high technology was eroding.[20]

When it was announced in February 1984 that Japan had built two of the world's fastest computers, technology transfer from the U.S. was identified as a factor. The benchmark test on one of the Fujitsu supercomputers indicated that it utilized very effective Fortran compiler software. It was also learned that some of the developers of that software had been students at the University of Illinois, which had specialized in this kind of computer research.[21]

While IBM's public announcement of its intent not to pursue the field of supercomputer research led some to wonder who would be capable

of responding to Japanese industry with its strong government backing and support, there was already a growing list of volunteers. For example, the Japanese announcement of the Fifth Generation Computer System Project prompted the chairman of Control Data Corporation, William Norris, to persuade several other companies to form a joint venture, Microelectronics and Computer Technology Corporation (MCC), to pursue pre-competitive research and development goals similar to, but in some respects broader than, those of the Fifth Generation Computer Project.[22]

Bobby Inman, President and Chief Executive Officer, views the stakes for MCC companies as concerning

> the development of technology and its commercialization with the goal being substantial share of the international market. If you look at the information handling industry, something on the order of $325 billion world-wide revenue for 1981. But what's more important than that year is the fact that its been growing at a compound rate of never less than 10% frequently closer to 20% over the decade which preceded and certainly is continuing at a fast rate with every reasonable expectation of a trillion dollar annual revenue base for the information handling industries by 1990. . . . It's fighting for a share in a growing market (unlike the problem in the automobile industry). On the other side of the coin, it was almost totally a U.S. market at an earlier point in time. What's happening increasingly is that the Japanese are making a major run for that market. . . . They haven't overtaken us in the creation of technology, but they've been much faster at implementing technology and taking it to the market place -- the commercialization of it.[23]

Some believe the private sector responses to Japan's challenge were insufficient. These concerns began to surface in Congressional hearings on the subject of U.S. competitiveness in the high technology and electronics industries. Legislation was proposed that might strengthen U.S. competitiveness. Soon the Japanese government and industry became concerned that the U.S. had overreacted. It was stressed that the Fifth

Generation Project should not be "interpreted the wrong way" and that in fact "American companies are invited to participate in that program and have not been set as a target."[24] Nevertheless, 1983 marked a year of increased government and industry concern over the Japanese competitive position.

d. Software: an art or an economic good? Protecting proprietary data. By the end of 1983 MITI had proposed a software rights bill to be submitted to the Diet. Two of the more controversial parts of the bill related to the term of copyright protection, and to the possible mandatory licensing requirements for software. The proposed term would be a mere 15 years as contrasted with the life plus 50 years of U.S. copyright protection.[25] Some U.S. companies hold that the longer period of protection is necessary since the useful life of their products can be 20 or more years.

A report from a MITI-sponsored industrial committee rejected the U.S. concept of software as a cultural development due protection for a long period and provided the following rationale:

> Programs are economic goods employed extensively for economic and business activities and are different in nature from works such as novels, art work, and music, covered by the current copyright law.[26]

This view is consistent with MITI's interest in seeing that software innovations are diffused throughout Japan and rapidly applied to the advancement of industry-wide state-of-the-art. The move by MITI came not long after a settlement between IBM and Hitachi regarding alleged theft of trade secrets, leading some observers to believe that Japan was seeking to nullify the settlements regarding the use of IBM software. American firms were also greatly concerned about the language in the bill. It was seen as potentially requiring "a software developer to

license and sell something that he might for some reason not wish to release."[27]

U.S. negotiators from the Department of Commerce soon entered the scene and attempted to forestall a crisis over the proposed bill. Their efforts were not alone, however. Japan's Education Ministry, which executes copyright law in Japan, also took issue with the MITI proposal. It was subsequently tabled but with an unanswered question: Are there adequate proprietary software protections?

2. Affecting and Being Affected by National Security Interests

Most national security emphasis on technology transfer is concerned with controlling the flow of technology, but favoring control or transfer depends upon who might be the recipient of the technology.

a. Coproduction concern. Between January 1, 1976 and June 15, 1980, there were over one hundred coproduction projects involving U.S. and Japan manufacturers joining together in producing military systems.[28] As the U.S. and Japan compete in more and more industrial sectors, the coproduction program has raised economic concerns in the U.S. Technology transfer is at the heart of the issue. For example, the coproduction program has created an ironic situation for some U.S. companies because of the national security interests involved in controlling the flow of military-critical technology to U.S. adversaries. U.S. companies complain that they are constrained from exporting the same products that they could transfer the technology for under coproduction arrangements.[29]

b. The reciprocal flow of defense technologies and concerns about diversion. In 1981 the U.S. initiated discussions with Japan on the

subject of the transfer of defense technology. Defense Secretary Caspar Weinberger said:

> The U.S. seeks the conclusion of a government-to-government understanding that will allow . . . the two-way transfer of technology on the basis of reciprocity. . . .
>
> The U.S. objective is the establishment of an environment conducive to long-term cooperation in the development and exchange of defense technologies to include, where appropriate, the transfer of materials and components.[30]

In November 1983 the U.S. and Japan signed an agreement on the transfer of Japanese defense technologies to the U.S.[31]

U.S. pursuit of an agreement on the exchange of defense technologies spurred discussion of three fundamental policy principles Japan follows regarding military arms exports: Japan will not export arms to communist nations, to countries to which the United Nations prohibits such sales, or to countries that may be involved in military hostilities. The Japanese government was able to alleviate somewhat the concerns that these principles would be violated. But the agreement brought anxiety to Japanese military manufacturers who "expressed concern that transferred technology might be diverted for production of non-military U.S. products."[32] Future technology transfers and the end results of those transfers may alleviate or heighten these concerns.

It is not clear how extensively computer software will be a part of the flow of defense technology from Japan to the U.S. The potential is real and there are some first indications of answers to the questions: Does technology transfer contribute to U.S.-Japanese mutual security? In exchanges of defense technologies, what additional controls, if any, should there be against undesirable re-export or diversion to commercial use?

c. Keeping technology from U.S. adversaries. Japan is allied with the U.S. in the attempt to stem the flow of technology that could be used to support the Soviet military build-up. This effort has posed difficult problems for the U.S., the foremost of which is the specific determination of what technology to control. The Department of Defense (DoD) has a major stake in preventing a Soviet military build-up based upon U.S. exported technology. In 1976 DoD commissioned a task force chaired by J. Fred Bucy, President of Texas Instruments, to recommend what technology should be controlled. The Bucy task force recommended a shift from controlling product technology to controlling manufacturing know-how technology, citing this sector's more critical military role. The recognition of the importance of manufacturing know-how as critical technology led to the 1979 Export Administration Act mandate that a Military Critical Technology List (MCTL) be developed and published by 1980 in the Federal Register so that manufacturers would know which technologies were permissible exports. As of mid-1984 the MCTL had not been published, and what has been completed remains classified by the DoD. The delay in publishing a completed list has been attributed to the complexity of constructing the list and reaching agreement on what is militarily critical.[33]

A second major issue has been foreign availability of critical technology. There is concern that U.S. allies such as Japan might be alternate sources of technology. The Department of Defense has on occasion harshly criticized Japan's and other allies' lack of effort in stemming the flow of technology to the Soviet Bloc. In 1983 one DoD official referred to an "unfettered flow of advanced military critical technology" from Japan and other allies.[34]

Various federal agencies have been debating with representatives of private industry and the academic and scientific community over the proper degree of technology transfer controls. Congress, which has the responsibility for overseeing all export control laws, has meanwhile been trying to determine what changes, if any, should be made in the existing legislation. In September 1983, the 1979 Export Administration Act expired without passage of new legislation. The failure to either renew or enact new legislation for export administration by mid-1984 was largely due to the controversies and questions surrounding the different interests that the legislation reflects, including: Is the transfer of technology to adversaries being adequately controlled? To what extent is foreign availability a factor?

3. Affecting and Being Affected by Foreign Policy and Political Interests

Foreign policy is an amalgam and political representation of economic, national security and other national interests. Hence, it has divided interests in both the free flow and the control of technology.

a. Seeking cooperation with U.S. allies. The Reagan Administration stepped up efforts to achieve COCOM cooperation in controlling technology such as computers and computer software targeted by the Soviet Bloc. In July 1984, it was announced that following two years of discussion the COCOM allies had agreed in principle on the ground rules for stemming the flow of technology to the Soviet Bloc countries.[35] For purposes of this report, the question is: Is there sufficient U.S.-Japanese cooperation within the COCOM framework regarding technology transfer?

Some Congressional leaders have suggested that COCOM allies have not diligently sought to control the flow of technology to the Soviet

Bloc. The State Department, which represents the U.S. in COCOM, underscored these concerns when it confirmed that COCOM allies in some cases do not have the means in place to control a COCOM-controlled item even if they wished to.[36]

Like most COCOM countries, Japan has had its share of incidents where the Soviets have tried to or have succeeded in acquiring technology. As noted in Chapter I, in 1982 a Soviet diplomat allegedly attempted to obtain computer software information from Hitachi and was expelled from Japan. It was subsequently reported that Japan's MITI would be tightening controls over possible technology leaks.[37] U.S. stakeholders will be observing how effectively MITI establishes and carries out such measures. MITI, like the U.S. Department of Commerce, is responsible for both promoting exports and protecting military critical technology from flowing to the Soviet Bloc.

One might ask, Why doesn't the U.S. pressure Japan to establish control measures? The U.S. administration only has so much leverage in attempting to influence its allies. This was probably best revealed in 1983 Senate hearings by an exchange between Senator Heinz of Pennsylvania and Richard Perle, Assistant Secretary for International Security Policy, Department of Defense:

> Senator Heinz: The other question, I guess, is why should we continue to provide the Japanese, or for that matter, Western Europe with a costly defense umbrella if they're determined to undermine our national security by selling or permitting the sale of this kind of sensitive technology to the Soviet Union?
>
> Mr. Perle: Because that umbrella keeps us dry as well, Senator. I think that we have to continue to try to persuade them that we're all under the same umbrella, and if they put holes in it, we're all going to get wet.[38]

b. Reflecting the overall U.S.-Japanese relationship. Another fundamental question in the foreign policy arena is: Has technology transfer been in consonance with the various aspects (economic, mutual security, political, etc.) of U.S.-Japanese relations? Is it now? As noted earlier, the U.S. foreign policy following World War II was designed to cultivate a free and independent Japan with democratic institutions and a robust economy. The U.S. freely provided Japan with technology to help the growth of its industrial base. The space industry has been a notable example. In 1969 the U.S. government agreed to "permit U.S. industry to export to Japan certain unclassified technology and equipment for the development of the Japanese [space] launch vehicles and for communications and other satellites" related to the Japanese Space Program.[39] In 1984 the U.S. extended an invitation to Japan and other allies to participate in joint development of a space station.[40]

Japan's emergence as a major factor in the high technology industries and a serious competitor for the U.S., has provoked calls to reassess the implications of the exchange of science and technology with the Japanese.[41] The Secretary of State has admonished the Japanese that their failure to commit themselves to free trade and to open their markets to American businesses could lead to U.S. protectionist legislation.[42] Success in handling Japan as a competitor in technology hinges on U.S. government and business interests' achieving a delicate balance between economic, national security and other policies. Because of the diversity of interests, some instances may require greater control of technology, while others could require a freer flow. Former

Governor Jerry Brown of California indicated the critical nature of this challenge as follows:

> [T]he concern I have is this . . . if we don't handle the Japanese relationship right, then we risk damaging an alliance that is central to the whole Western prosperity. And if we alienate Japan, there is no reason why Japan can't work with China or Russia and move totally in a different orbit.[43]

c. Technology as a foreign policy tool. The use of technology for foreign policy purposes has been one of the most controversial and, at times, inconsistent aspects of U.S. policy. Denying an export license can be done swiftly and easily, and need not affect future transactions. These features make export license denial particularly attractive for foreign policy purposes. It can be used to signal human rights concerns, abhorrence of aggression, and other political messages.

The very features that make the denial of a license attractive as a foreign policy tool alarm exporters. They fear that foreign policy initiatives evolving from administration to administration will jeopardize or curtail their prospective sales. One of the most famous cases of export denial licensing policy was the decision by President Carter in July 1978 to deny Sperry-Rand Corporation's application for a license to export a computer to Tass, the official news agency of the Soviet Union. The Carter administration indicated that this and other actions had been taken to protest sentences imposed on dissidents within the Soviet Union.[44] When the Carter administration sought allied cooperation in a coordinated denial of this technology to the Soviet Union, France would not cooperate. A French firm then concluded an agreement to provide the Soviets with a similar computer. Ironically, Sperry-Rand was later issued a license to export a modified computer.

U.S. allies have also been critical and suspicious of export control for foreign policy purposes. They suspect a country that denies export of technology for political purposes of wielding a commercial advantage over the other countries in the alliance on grounds that the country could keep its intentions secret until the last moment and then take the initiative in determining when it is permissible to make the technology available again.[45] For the above reasons one must ask: Are U.S. policies perceived clearly and consistently by Western Europe and Japan regarding technology transfer to the Soviet Bloc and China?

The China market will be critical for U.S. and Japanese technology. Both the U.S. and Japan have been actively pursuing that market since they share a common goal of "promoting China's modernization and encouraging China's constructive engagement in Asia."[46] In the past, the Department of Commerce and the Department of Defense have not always agreed on what technology should be made available to China, especially with respect to computers and computer software.[47] Chinese officials have made it clear that they will not passively wait for the U.S. administration to decide. If the U.S. government is not forthcoming, China will "turn to Japan and Western Europe for help."[48]

d. Strains on the Western European economy and the Atlantic Alliance. As indicated earlier, the announcement of the Fifth Generation Project in Japan raised economic concerns in the U.S. Similar concerns were expressed in Europe. For example, the U.K. Department of Industry formed the Alvey Committee in 1982 to investigate the competitive threat and propose the government's response. In 1983 the Proposal for a Council Decision Adopting the First European Strategic Programme for Research and Development in Information Tech-

nology by the European Community made it clear that Europe could not afford "to remain an observer" as the U.S. and Japan continued their high technology initiatives.[49] Furthermore, European manufacturers do not rely solely on their individual governments' efforts to maintain their competitiveness. Several European manufacturers have formed ventures and joint research consortia in response to the Fifth Generation challenge.[50] And some computer companies have called for new industrial and social policies to help the native industry compete more vigorously at home and abroad.[51]

At a 1983 meeting of the North Atlantic Treaty Organization (NATO), it was reported that U.S. curbs on technology were hindering NATO unity.[52] NATO and COCOM have been forums for addressing the controversial issues and questions of technology transfer in the context of the Western alliance. U.K. Minister for Trade and Industry Norman Tebbit found it necessary in 1984 to respond to criticism that the U.K. may be lax in export controls:

> We are 3000 miles nearer the tanks, our concern for the strong Western alliance is at least as keen as the concern of those in Washington. . . .
>
> I hope misinformed critics who sometimes suggest that we in Europe are going soft on the control of strategically important technology will recognize that what we want is greater effectiveness, through selecting the things that matter.[53]

Brian Oakley, head of the Alvey Directorate, reportedly suggested that U.S. technology transfer policies could lead to undesirable consequences for the alliance:

> Damn it all, we are their allies. . . .
>
> Our communities could drift apart because they could no longer buy each other's products. . . . Indeed, by encouraging European countries to seek other partners,

> particularly Japan, the U.S. could find itself facing an anti-American alliance.[54]

The concerns in British government and industry are reported to run deep. "Perhaps the strongest comment has come in an internal report prepared by [the British computer firm] ICL, which was leaked to the British press" in early 1984. "The report accused the United States of practicing 'growing technological imperialism.'"[55] One must try and sort out from the many charges and countercharges the specific concerns of the stakeholders. David Talbot, Alvey's Director of Software Engineering, made it clear that software technology transfer policies are a part of the problem. For example:

> Take ADA. That is a marketing standard for U.S. defense contractors. It's likely that it will become a standard within NATO. While the basic ADA language is in the public domain, the more advanced technology tools, the [ADA programming support environments] have a fair chance of not being exported [from the U.S.], or might be exported, but restricted in such a way that contractors in the U.K. who wanted to bid ADA for a military contract would not be in a position to commercially go and get that advanced technology in order to support their bid.[56]

Although the ADA suport environment has yet to be developed, Talbot's comments reflect a common suspicion in the U.K. and elsewhere in Western Europe that this support environment would not be available outside the U.S. All non-U.S. contractors could be at a disadvantage in bidding for contracts in support of NATO and mutual security. There may be some grounds for this concern since the ADA support environment meets the criterion for the most militarily critical technology. (See Appendix.) While DoD may continue to encourage exporting and allied use of ADA reference manuals and compilers, will DoD block the transfer of the support environment to U.S. allies when it becomes available?

These national security and economic concerns raise the question: Do the U.K., France, and West Germany consider U.S. and Japanese computer software technology and technology transfer policies a threat to Western Europe's economy and/or the NATO alliance?

4. Advancing Science and Technology in the U.S. and Japan

Successful transfers of computer software technology between the U.S. and Japan are a frequent and rather routine occurrence. These transfers take place in academic settings and at professional gatherings, through the open literature, during visits to computer companies, and by establishing joint ventures or overseas affiliates. Most transfers receive little attention, even in professional journals. But the long-term benefits go beyond economic or even scientific gain. In some cases they help to overcome cultural obstacles. For these reasons it is important to know: To what extent is software technology transfer between the U.S. and Japan affected by or contributing to the advancement of science and technology, or cultural and humanitarian objectives? Is there a consensus on what constitute the important computer software technologies? Are resources being focused on the most important areas?

Japan's government set up an institution specifically for software technology acquisition and diffusion, having determined that it was necessary to bring "new concepts in software engineering into daily practices for the sound growth of the industry."[57] In 1976 the Joint System Development Corporation was established by 17 leading software firms in Tokyo. MITI guided this joint effort and provided financing through the Information-Technology Promotion Agency.

In an attempt to be more competitive in the Japanese market, American computer manufacturers have had to develop hardware and software capable of handling the complex Japanese Kanji characters as well as the traditional Roman alphabet. For example, Digital Research of Japan announced in 1984 that it had developed a Kanji version of its widely used micro-computer operating system.[58] Also, IBM Japan has developed a personal computer/word processor capable of handling Kanji characters.

While technology transfer was the means or goal of these positive efforts, it was also the source of considerable controversy. As mentioned earlier, some in the artificial intelligence community were alarmed that Japan's Fifth Generation Computer Project was capitalizing on technology that originated in the U.S. But others were skeptical of the promises that had been made for more than 20 years regarding AI and believed that scarce financial and talent resources should be devoted to supercomputers or other computer technologies.[59] This skepticism was not confined to the U.S., but also surfaced in Japan's computer laboratories.[60]

To compare the relative importance and position of technology in the U.S. to that in Japan, one must look beyond product technology, such as that embodied in a computer language, and consider developments in process technologies. Some software experts and observers have noted that while the U.S. may be the source of the important software engineering and software manufacturing technologies, Japan has at times been more successful in the application of these technologies. (See Appendix.)

B. THE U.S. GOVERNMENT AND BUSINESS RESPONSES -- FROM LAISSEZ FAIRE TO THE PROPOSED DEPARTMENT OF INTERNATIONAL TRADE AND INDUSTRY

1983 was not only a time for deliberations over technology transfer issues raised by the impending expiration of the Export Administration Act. It was also a time for an introduction of new initiatives in response to the growing Japanese high technology challenge, especially in the area of computers and computer-related products. Congressional testimony revealed that some U.S. business and professional interest groups were concerned that the U.S. lacked the data or assessments with which to determine its relative competitiveness.[61] Others decried the lack of facilities for doing further research in sophisticated technologies such as supercomputers. For instance, one university spokesperson indicated that there was a significant "lack of access, lack of availability, lack of funds, lack of trained computer scientists, lack of software, and lack of communications linkages" needed to respond to the challenge.[62]

One example of proposed legislative remedies to the challenge presented by increased Japanese trade in high technology was S.121, which called for the establishment of a Department of International Trade and Industry. Senator William Roth of Delaware, in his opening statement in 1983 hearings on the proposed bill, said:

> Make no mistake about it, we are involved in a trade war. Unfortunately, we are dealing with a situation with what I call a Model T Ford. The U.S. is one of the few countries that is not organized to pursue an aggressive trade policy, and make no mistake, strong organization means strong policy. Strong policy is not possible without strong organization.[63]

In contrast to those issuing cries of alarm and scrambling for resources to address the Japanese challenge, there are times when others

are proceeding calmly with joint ventures and increasing flows of technology between the two countries. For example, one industry giant, Mitsubishi; the daughter of another, IBM Japan; and a Japanese software-oriented venture firm have formed a joint venture to develop and market hardware and software. Also, Mitsubishi has recently acquired equity in a U.S.-based software house and forged a linkup between the U.S. firm and a Japanese software developer, ultimately intending to market its products in Japan.[64]

In light of these responses and surrounding controversies, a second major issue has been raised, in part a result of U.S.-Japan technology transfer activities: Are the U.S. government and business communities prepared to deal with issues affecting or affected by U.S.-Japan technology transfer now and in the future?

While the 1983 legislative proposals for dealing with Japan's high technology challenge do not all focus on technology transfer, it is clear they focus on the Japanese and, to some extent, Western European competition. What, if any, of this legislation is enacted will depend in large part upon how the various stakeholders; their stakes; their respective tugs, pulls, and strains on policies and actions; and the different national interests, are accommodated.

C. SUMMARY

A brief survey of the stakeholders and their stakes indicates that there are two fundamental issues associated with U.S.-Japan technology transfer. First, how can the right balance be achieved in policies and actions affecting or affected by technology transfer? Second, what should the U.S. response be to Japan's new strength as a competitor in high technology industries such as computer hardware and software? Both

issues are, of course, a matter for political resolution, but the long-run implications of various policy options can be better dealt with by first understanding what constitutes the overall national interest.

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III. NATIONAL INTERESTS -- A GUIDE TO POLICY IMPLICATIONS

National interests help anchor national policies and actions. National interests can evolve and shift over the long term under strong pressure, but more commonly they are amended deliberately in response to specific issues. To understand the technology transfer issue in its full context, it should be considered from the perspective of national interests, the interests and stakes of the various players, and the interests of other nations. It is also important to understand the interrelationships between actual and proposed technology transfer actions and policies and the national interests.

A. UNITED STATES NATIONAL INTERESTS

The United States does not keep a running account of its national interests, let alone how the transfer of technology might affect them. But reviewing technology transfer literature has contributed to a composite list of national interests. Table D merges two U.S. administrations' efforts to develop a list of national interests and/or objectives: President Eisenhower's Commission on National Goals, and President Carter's Commission for a National Agenda for the Eighties.[1]

1. Economic Interests/Objectives
   a. Increased productivity with sustained economic growth as reflected in real income per capita
   b. Full employment
   c. Relative stability of average prices
   d. Equitable income distribution and equitable taxation
   e. Maintenance of effective domestic competition and international competitiveness
   f. Limited and smooth structural adjustment in the economy
   g. Fair, free and balenced trade
   h. Security from resources scarcity
   i. Preservation and improvement of environmental quality and living conditions*
   j. Consumer protection*

2. National Security Interests/Objectives
   a. Minimize the offensive military capabilities of actual or potential enemies of the nation
   b. Increase the defensive and offensive military capabilities of actual or potential allies
   c. Preserve U.S. and allied independence and self-determination

3. Foreign Policy and Political Interests/Objectives
   a. Cooperation with other countries, bilateral and multilateral
   b. Resolution of conflict by peaceful means; safeguarded arms reductions
   c. Preserve and perfect democratic processes and institutions

4. Scientific, Cultural and Humanitarian Interests/Objectives
   a. The advancement of science and technology
   b. Improvements in education
   c. Planned technological change
   d. Aid the economic development of lesser developed countries
   e. Enhance human rights, including the rights of the individual, justice and equality
   f. Provide for more effective health and welfare

*These interests/objectives are combined economic and social or humanitarian.

Table D

U.S. National Interests/Objectives

The spectrum of national interests leads to policies and supporting actions that occasionally conflict in the context of certain issues. Technology transfer typifies the kind of divisive issue that requires the resolution of conflicting policies and actions through a close examination of the various interests involved. It is also helpful to consider some examples of issues, questions, and stakeholders presented earlier to better understand their relation to these national interests.

1. Economic Interests

Historically, the economic debate over technology transfer in the U.S. has revolved around several prevailing issues: technology transfer provides a return on investment to the U.S. licensor of the technology, but may also result in exporting jobs; it may accelerate the development of foreign competition; U.S. technology-exporting firms may be setting too low a price on their technology; and the export of technology may promote international division of labor, and narrow the industrial base.[2] In recent years technology transfer and technology acquisitions have continued to focus on these international economic ramifications as well as others. For example, the protection of proprietary data across international boundaries has been of growing concern.

William Norris, Chairman of Control Data Corporation (CDC), suggested in 1983 that the U.S. may need to "place controls on Japan's access to our advanced technology" in order "to obtain an equitable trade arrangement" with Japan.[3] This is an example of evoking the national interest in fair, free and balanced trade, and it raises the following questions: When is technology transfer in the national interest? To what extent is it affected by or contributing to national

economic interests? And does technology that is transferred receive fair value?

As mentioned earlier, the announcement of successful benchmark tests on two new Japanese supercomputers in 1983 heightened concern among some U.S. observers about the U.S. ability to compete in this field. Others believed that the U.S. position of leadership was not necessarily threatened. In the latter category was Robert Cooper, Director of the Defense Advanced Research Projects Agency (DARPA) that manages a DoD-funded project involving state-of-the-art computer technology.[4] He is concerned that the U.S. has a sufficient industrial base for computer technology development, and the national economic interest is upheld through the maintenance of effective domestic competition and international competitiveness. DARPA is also committed to the national security interest of minimizing the offensive military capabilities of actual or potential enemies of the nation by staying ahead of other nations in computer technology development. Hence, the agency has a significant stake in both the U.S. computer industry's economic competition from Japan and the military threat of the Soviet Union.

Table E shows the relationship between these two examples, issues, questions, stakeholders, stakes, and national interests.

Example of Issues	Examples of Stakeholders . . . . and their Stakes		National Interests
When is technology transfer in the national interest? When more than one U.S. national interest is involved, as is often the case in technology transfer between the U.S. and Japan, how should the U.S. prioritize or achieve the right balance among policies effecting technology transfer? To what extent is technology transfer between the United States and Japan affected by or contributing to national economic interests?			
Does software technology that is transferred receive fair value? If not, should U.S. companies raise the price or restrict access to their technology?	William Norris, Chairman, Control Data Corporation	Technology made available to Japan too cheaply?[5]	Economic: Fair, free, and balanced trade.
Is there a sound basis for concluding that the U.S. computer industry will encounter the same kind of stiff competition from Japan as the steel, automobile, consumer electronics and integrated circuit industries have? If so, to what extent is software technology transfer a factor? What are the best policies for meeting U.S. national economic interests/objectives: free flow of technology, collaboration, protectionism, or increased support for U.S. research and development efforts?	Robert Cooper, Director, Defense Advanced Projects Projects Agency	Research in supercomputational technology. DARPA manages the DoD-funded Strategic Computing Project.[6]	Economic: Maintenance of effective domestic competition and international competitiveness. National security: Minimize the offensive military capabilities of actual or potential enemies of the nation.

Table E

Examples of Major Issues and Questions, Stakeholders, Stakes, National Interests

2. National Security Interests

Economic concerns about technology transfer frequently relate to national security interests. There is always the possibility that technology exported by U.S. firms for commercial purposes will be diverted to potential or actual adversaries for military purposes.[7] Certain technologies encompass both national security and economic interests; it becomes very difficult to determine whether to permit the export of a technology that has potential for commercial use as well as military application. The dual use technology of computer hardware and software has precipitated a clash between not only U.S. national security and economic policies but with foreign policies as well.

In 1981 Secretary of Defense Caspar Weinberger initiated discussions with Japan on the subject of the transfer of defense technology. In 1983 the U.S. and Japan signed an agreement on the exchange of defense technologies.[8] Although it is not yet clear to what extent that computer software will be involved, this agreement clearly demonstrates the national interest of minimizing enemies' capabilities by increasing one's own. It also provides a partial answer to the question of whether technology transfer contributes to U.S.-Japanese mutual security.

Despite the 1983 agreement, concern about national security interests in technology transfer between the United States and Japan persists. In 1983 Under Secretary of Defense for Research and Engineering Richard DeLauer was asked how the Soviets obtained U.S. military secrets. He replied that he thought "the leakiest place in the world was Tokyo."[9] DoD's stake in technology transfer to Japan includes assurance of Japan's ability to control militarily critical technology

because of the national interest of minimizing enemy capabilities. Addressing these concerns and interests prompts such questions as: Is technology transfer to adversaries being adequately controlled? To what extent is foreign availability a factor?

3. Foreign Policy and Political Interests

Technology transfer can influence foreign policy in several ways. Measures to encourage or limit access of nations to technology held by one nation have led to major political issues. The promise of preferred access to technology has been used as a foreign policy tool. Technology advances are sometimes viewed as threatening to the sovereignty of nations. Certain technologies have served as the basis for international collaborative efforts.[10]

Technology transfer was an important tool in accomplishing the U.S. post-World War II objective of developing a free and independent Japan.[11] The success of that foreign policy is reflected in the current economic focus of U.S.-Japanese relations. Japan has a strong technological capability and is a strong global competitor. The United States now has an unfavorable balance of payments with Japan, although the two nations share many goals.

Japan continues to play an important role in COCOM. Officials at the State Department have expressed concern that Japan and other allies may not necessarily have the mechanisms to enforce controls on those technologies that COCOM may agree to embargo.[12] The U.S. stake in COCOM is the allied cooperation in technology transfer. The national interests that are involved include maintaining competition, reducing or minimizing enemies' capabilities, and cooperating with U.S. allies. Is

there sufficient U.S.-Japanese cooperation within the COCOM framework regarding technology transfer?

President Carter's decision to deny Sperry Rand Corporation's application for a license to export a computer to Tass was cited earlier as an example of the use of technology transfer as a foreign policy tool. The same case illustrates how national interests are involved. The Carter administration indicated that this and other actions had been taken to protest sentences imposed on Soviet dissidents.[13] Carter's ruling not only upheld the national interest of minimizing enemy capabilities, but also that of enhancing human rights. This particular incident and others stirred concern in Western Europe about the appropriate use of technology transfer as a foreign policy tool and raises the question: Are technology transfer policies perceived clearly and consistently by Western Europe and Japan regarding political exigencies?

Both the United States and Japan have been interested in developing and modernizing China and influencing China's "constructive engagement in Asia."[14] Secretary of State George P. Shultz invoked this common goal at the Sixth Shimoda Conference in 1983. This illustrates the United States' and Japan's shared interests in cooperation with other countries and in aiding the economic development of lesser developed countries. Clear and consistent technology transfer policies with respect to China will be important for the United States and Japan. China has already indicated that if it does not get a clear signal from Washington, it will look to Tokyo and Western Europe for the technology it seeks.

4. Scientific, Cultural, and Humanitarian Interests

The First Amendment to the Constitution protects the vital interests of free expression. But when it comes to technology transfer, scientific and academic stakes can clash with national security interests over the issue of stemming the flow of critical scientific and technological information to U.S. adversaries.

On the positive side, technology transfer has shown the potential for assisting in overcoming cultural obstacles. The advancement of science and technology has been greatly facilitated by computers and computer technology. U.S. businesses and government organizations have invested heavily in the advancement of computer science and technology. The further advance of this technology is aided by the exchange of scientific information within the United States, and between the United States and other countries.

National Academy of Sciences President Frank Press told the House Judiciary Committee in November 1983 that he was concerned about government interventions and actions to control scientific communications. He was basically expressing the national interests in advancing science and technology and preserving and perfecting democratic processes and institutions, namely, First Amendment protection.[15] At stake for the academic community was the free exchange of scientific and technological information and the continuation of contracts between the community and the Department of Defense. The question some have asked is whether technology transfer to adversaries was being adequately controlled in the academic environment.

Sometimes concerns about international technology transfer go hand in hand with concerns about domestic diffusion of technology. An

example affecting U.S. interests was reflected in an article written in 1983 by Barry Boehm of TRW. In a pitch for the use of the ADA computer language and shared software development environments, he said:

> This is a matter of some national concern, for it is likely that our worthiest international competitors would opt for shared use and higher productivity, thus giving themselves a real competitive edge in the computer industry.[16]

Thus software technology transfer between the United States and Japan, as well as technology diffusions within these two nations, may contribute to the advancement of science and technology. At stake for U.S. government and business is the decision of where to focus U.S. technology efforts in the international competition for improving productivity. The national interests involved are the advancement of science, maintaining domestic competition and international competitiveness, and increased productivity.

An important contrast between the military/political challenge the U.S. faces from the Soviet Union and the economic competition from Japan becomes ever more clear when viewed in the context of the open societies of the U.S. and Japan and the state-controlled society of the Soviet Union. The basic differences in political national interests have important affects on technology assimilation and diffusion. The plurality of players in Japan such as MITI, NTT, Hitachi, and Fujitsu that are agents in the acquisition, assimilation, and diffusion of computer software technology should be contrasted with Soviet steps to control citizen access to photocopy machines, direct long-distance dialing, and personal computers.[17]

In 1983 IBM Japan introduced its 5550 Multistation with Japanese language capability, and the following year, Digital Research Japan announced that it had developed a Japanese language or Kanji version of

its popular microcomputer operating system, CP/M.[18] These developments and similar innovations by other U.S. and Japanese manufacturers will facilitate the Japanese use of computers in office automation and computer program development in their native language. In terms of future market potential, one need only consider that it is a relatively simple modification to convert the same technology used in the IMB 5550 or Japanese version of CPM for use elsewhere in the Orient. IBM has already produced a Chinese and Korean version of the 5550.[19]

B. JAPAN'S NATIONAL INTERESTS

In general, Japan's national interests are very similar to those of the United States. But a closer look reveals some significant differences.

1. Economic Interests

Probably the most striking difference between Japan and the United States in the postwar period and beyond has been the evolution of Japan's major goals, from rebuilding its industries, to becoming as economically sound as other modern industrial nations, to catching up to the United States in industrial effectiveness and efficiency. Upon attaining success in the steel, textile, automobile, consumer electronics, and other industries, Japan by the early 1980s had begun to reassess its future economic goals from a perspective of strength and leadership.

Japan is a nation of very limited national resources. Japan has a transformation economy; that is, it must import those natural resources which it does not have, and manufacture and export value-added products. This by definition makes Japan dependent upon international trade. Thus Japan's effort to overcome resource limitations is no surprise. But

what did surprise many business interests in the U.S. was Japan's aggressive, head-to-head economic competition in the communications and information industries. The Japanese have rationalized that this industrial sector holds the most promising economic future for Japan.[20]

One of MITI's most influential policies in the area of the computer industry was a 1957 law to promote the electronics industry in Japan:

> The Ministry of International Trade and Industry has taken the view that Japan's future lies in control of electronics technology. As early as June 1957, MITI enacted a "law on temporary measures for promotion of the electronics industry" with the purpose of fostering production of electronics within Japan. . . . To compete with IBM, which held a 60 percent share of the world computer markets, MITI quickly formulated policies to protect and foster domestic technology.[21]

Prior to closing the gap with the United States in the automobile, consumer electronics, and other industries, Japan's protectionist support of its fledgling industries did not concern U.S. business interests: It seemed a reasonable and logical holdover from postwar interests in the reconstruction of Japan. Japan's industries closing the gap became a different matter.

Like the United States and its Western European allies, Japan's business interests benefited from detente. According to one account, a significant portion of Japan-Soviet trade involved computers and related products.[22]

Japan has been wary about the unintended economic consequences of its trade in technology. It is concerned about reducing its trade surplus with the European Community.[23] Japanese businesses are also concerned that defense technologies that Japan provides to the United States might be diverted to commercial purposes and thereby become competitive with Japanese companies in the same or related industries.[24]

Japanese government and business interests have been sensitive to claims that their market is inaccessible to foreign businesses. U.S. firms have charged that they are not able to compete in the Japanese market. Nippon Telegraph and Telephone Company (NTT) International Procurements Director Ichio Kata stated in 1984 that "[c]ontrary to what you may have heard, the Japanese telecommunication market is not closed to U.S. suppliers."[25] Are the ground rules of economic competition fair to both the U.S. and Japan? U.S. businessmen have charged that Japan's government has worked in tandem with its business interests to unfairly shield the Japanese market from U.S. penetration. In 1980, Sadanori Yamanaka, Minister of International Trade and Industry, refuted such charges:

> One of the most important functions of the state is to facilitate economic development and to enhance the popular welfare. Since industrial activity is the cornerstone of national economic development, all states practice a wide variety of industrial policies, albeit under different names and in different forms.[26]

This example reflects MITI's concern for two national interests: maintaining domestic competition and international competitiveness, and achieving world economic leadership based on a transformation economy.

MITI has considerable stake in computer research and development. MITI is not only interested in protecting the rewards from this research, but also in swiftly implementing the fruits of research and development. As mentioned in Chapter II, these stakes were behind MITI's 1983 proposed software rights bill, which had two controversial parts: one providing for a shorter term of copyright protection than is provided for in the United States, and the other citing circumstances that could "require a software developer to license and sell something that he might for some reason not wish to release."[27] At least three

Japanese national interests are involved here: fair, free, and balanced trade; the advancement of science and technology; and economic leadership. In question is whether there are adequate protections for proprietary software that is transferred between the United States and Japan.

2. National Security Interests

Mutual security is another interest shared by the United States and Japan. Since the end of World War II, however, Japan's budget for its Self Defense Forces has rarely exceeded one percent of its gross national product, in contrast to the U.S.'s six percent. Some in the United States have charged that Japan has been getting a "free ride" from the existing mutual security treaty between the United States and Japan.[28]

While Japanese security interests are similar to those of the United States, they fundamentally diverge on the issue of armed conflict. Unlike the U.S., Japan will avoid conflict unless its security is directly threatened.[29]

Japan, in the manner of the U.S. and most other industrialized countries, maintains a "communications sovereignty." This requires barring foreign-affiliated firms from establishing vital communications services within national borders. In July 1983 when IBM Japan revealed its intention to begin telecommunications services in Japan, there were wide repercussions because of the perceived transgression of Japanese communications sovereignty.[30]

Japan has followed three principles regarding military arms exports: it will not export arms to communist nations, countries to which the United Nations prohibits sales, and countries that may be

involved in military hostilities. The November 1983 announcement that the United States and Japan had signed an agreement on the transfer of Japanese defense technology to the United States signaled the resolution of issues that had been raised in Japan regarding these three principles. It was reported that a Joint Military Technology Commission would be established to examine specific requests for each transfer of technology.[31] The commission will be comprised of representatives from Japan's Defense Agency, Foreign Ministry, and International Trade and Industry Ministry, and the U.S. Mutual Defense Agreement Office and Embassy in Tokyo. As mentioned earlier, business interests in Japan were concerned about the possible diversion of military technology to commercial enterprises in the United States. Japanese government agencies were concerned about the possible diversion of military technology to third countries as well. The Japanese national interests that were involved in this matter included the maintenance of international competitiveness, cooperation with an ally, and increasing the defensive and offensive military capabilities of an ally. At issue was whether there should be additional controls on the exchange of defense technologies to prevent undesirable re-export or diversion to commercial or other uses.

In 1983 Foreign Minister Abe was reported to have said that the government may soon take steps to restrict the outflow of high technology to the Soviet Union. This was viewed by some as a response to charges that Japan was not doing enough to protect the outflow of military critical technology to mutual adversaries of the U.S. and Japan. At stake for the Foreign Minister was Japan's control of its technology exports. The overall national interest was that of

minimizing the capabilities of real or possible enemies. The question was whether technology transfer to adversaries was being adequately controlled.

3. Foreign Policy and Political Interests

A relatively recent change in the thrust of Japan's foreign policy has been Japan's desire for an increasing role in the world community. According to MITI's vision of the 1980s, "Japan must contribute as much as possible to laying the foundation for the maintenance of world peace and the development of the world economy."[32] MITI made it very clear that technology transfer would play a role in carrying out Japanese foreign policy:

> Japan will contribute by opening its facilities for research and development to foreign nations, including the establishment of a research institute inviting world-renowned researchers in the field of life science and energy.
>
> The transfer of technology to developing countries is one of the most important fields for Japan to contribute for the purpose of international cooperation.[33]

In cooperation with the U.S. and other industrial nations, MITI has been staking out a stronger role regarding lesser developed nations. Japan's national interest is that of cooperation with other countries as well as aid to lesser developed countries.

Japanese Prime Minister Yasuhiro Nakasone made it clear in 1983 that a new role in the world community was in the national interest:

> Today there can be no doubt that we are on the verge of a new economic and cultural sphere that, while centering on Japan and the United States, will encompass the Pacific shores in both the Northern and Southern Hemispheres. . . . The Pacific Ocean is becoming the new and historic stage of human interaction for the drama of human interaction and development.[34]

4. Scientific, Cultural, and Humanitarian Interests

There has been a recent shift in the Japanese stance toward the advancement of science and technology. While in the past Japanese industry achieved brilliant results in improving on imported technologies, MITI has now declared that Japan must research and develop technologies of its own.[35]

Whereas the U.S. historical and cultural ties are primarily with Western Europe, Japan's is culturally linked to China and other Asian nations. Japan is also a very homogenous nation, and it is a matter of national interest to preserve this homogeneity. These are major historical differences between the U.S. and Japan that may help explain the Japanese distrust of foreign or Occidental conventions. Japan's interest in group cohesiveness may also account for its stunning success at technology acquisition and assimilation. Japanese management is well known for emphasizing consensus building at every level before decision making. Japanese workers exhibit an eager willingness to accept new production technologies, and usually participate actively in the process of ascending the learning curve of manufacturing productivity.[36]

Japanese homogeneity and cultural values obviously contribute to what one observer calls Japan's "concerted economic game plan." When visiting Japanese computer manufacturers and MITI in 1982, this same observer repeatedly heard the phrase "the nail that stands out gets hammered down." Yet while Japanese homogeneity can contribute to innovation and technology assimilation, "they don't seem to foster the entrepreneur," nor a vital environment for basic research.[37] Some Japanese observers share this view. For example, Masanori Moritani says:

> High-technology development in Japan requires only that . . . traditional self-assertion be given greater scope, and that Japanese companies work actively to encourage it. The greatest issue that Japanese managers of this kind of development drive will have to puzzle over in the years ahead will be how to permit the existence of individuality, indeed, how to encourage it, while somehow working out a compromise with group harmony.[38]

An example of Japan's ability to assimilate and diffuse technology was the 1976 establishment of the Joint Systems Development Corporation by 17 leading software firms in Tokyo. MITI guided this joint effort and provided financing through the Information-Technology Promotion Agency.[39] At stake was the realignment of Japan's software technology effort in support of the national interest of advancing science and technology in the information industries.

While Japan embraces the acquisition, assimilation, and diffusion of technology, it is no less prone than the United States to differences of opinion over what technology is most important. Authorities in the United States have been skeptical about the wisdom of investing resources in artificial intelligence technology development. Japan has had its skeptics as well. Hiroshi Yamada, Director of Fujitsu's laboratories, has said:

> We do R&D on computers, while [the Fifth Generation Project Organization] ICOT follows an academic path. . . . ICOT's work may trigger some commercial systems, but from a business standpoint we're not sure we can make a computer like the human brain.[40]

In sum, present Japanese national interests are generally the same as those of the United States, but with three important additions: gaining world economic leadership based on a transformation economy, avoiding armed conflict unless there is a direct threat to security, and preserving Japan's homogeneity and group cohesiveness. The first two

are relatively recent (post-World War II) precepts; the third is as old as Japan.

C. THE INTRICATE WEB OF U.S. AND JAPANESE NATIONAL INTERESTS, POLICIES, AND ISSUES

At this point, it would be useful to illustrate the linkages between technology transfer activities and national interests. They can be illustrated by focusing on both U.S. and Japanese national interests in the transfer of technology. Figure 1 portrays relationships between technology transfer activities and national economic objectives.

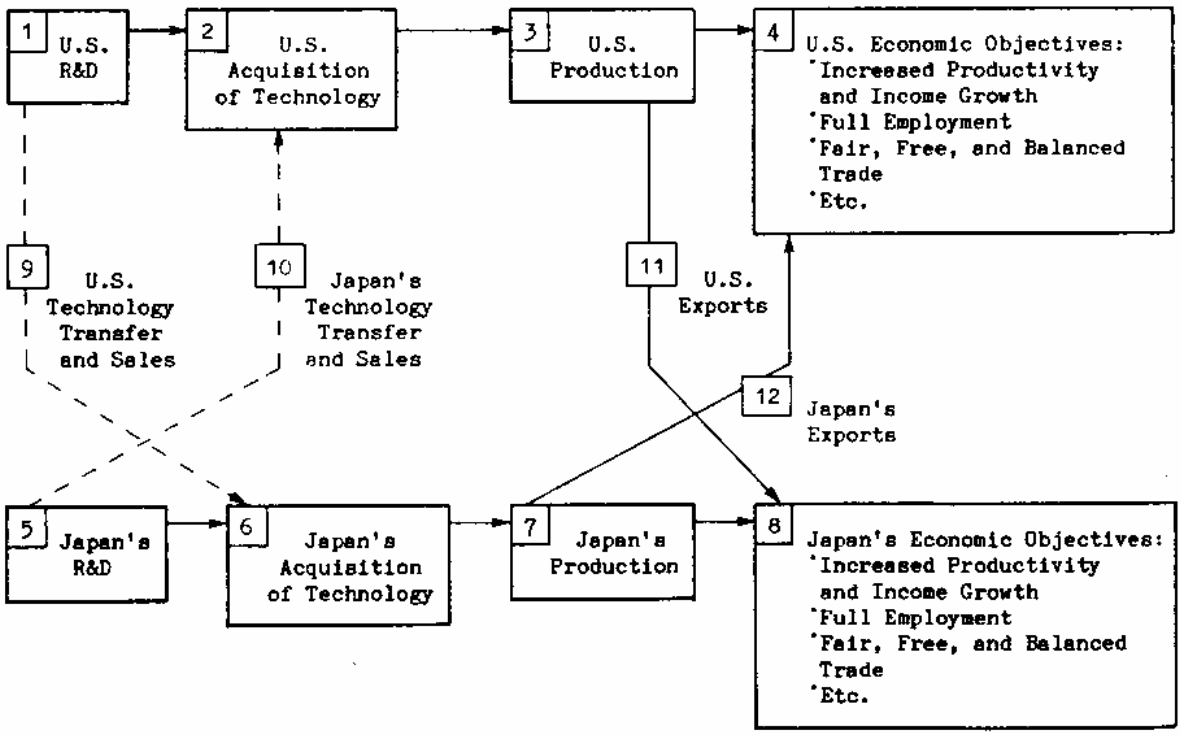

Figure 1

Linkages Between Technology Transfer Activities and Economic Objectives

The purpose of Figure 1 is to show the general flow, principal factors, and key linkages. It by no means accounts for all the possible flows, factors, and linkages. For example, the linkages to U.S. policy, alternate sources of technology, and the possible acquisition of technology from products by means of reverse engineering are omitted from Figure 1 for purposes of simplification.

The following hypothetical scenario is presented to illustrate how technology transfer policies and actions in support of U.S. and Japanese national interests can raise issues and questions that are difficult to resolve.

Let's say that the U.S. has a number of defense-related coproduction programs with Japan. One of the largest is coproduction of F-15 fighter planes in support of mutual national security interests. But because of national security concerns, the U.S. has not provided the Japanese with the technology for developing the sophisticated computer systems used in the F-15. Instead, the U.S. "black-boxes" such products to the Japanese for installation in the planes as completely assembled components. ("Black-boxing" is providing someone an installed product in a manner that precludes the recipient's access to the technology associated with the product.) Japan, like most other countries, does not want to rely on another country for defense-related technology. Accordingly, in this fictional scenario three Japanese manufacturers are asked by the Japanese Defense Agency to jointly develop systems equivalent to those the U.S. black-boxes.[41]

To continue, the three Japanese companies rise to the challenge and design a system so miniaturized that it fits in the palm of one's hand, or about one-quarter the size of a typical American system.[42] Thus the

U.S. could unintentionally encourage the Japanese to develop technology with significant commercial as well as security application.

In some cases Japanese-U.S. defense aircraft coproduction work takes place in facilities adjacent to the plants that produce Japanese commercial aircraft.[43] It does not take much imagination to speculate that this newly developed computer hardware and software technology may find its way through a couple of plant doors into civilian aircraft production because of strong economic interests. After all, Japan is locked in competition with the U.S. in the civilian aircraft industry.

The U.S. Department of Defense is well aware of Japanese technological capabilities. In 1983 the U.S. concluded an agreement with Japan on the exchange of defense technologies.[44] It is conceivable that DoD might someday want to exercise that agreement and try to acquire the improved design miniaturized computer systems from the Japanese. But whether the Japanese would be willing to oblige U.S. national security interests is uncertain. Japanese manufacturers have already expressed concern about the agreement to exchange defense technologies. They are concerned that technology acquired by the U.S. could be diverted for commercial purposes and end up competing with Japanese industries.[45] They are also concerned about possible diversion to third world countries, which are increasingly proving to be competitors for Japan.

This speculative exercise shows typical cause and effect relationships affected by or affecting technology transfer. It is complicated when only the U.S.-Japanese relationship is considered. The complexity is compounded when major Western European powers enter the picture.

D. WESTERN EUROPEAN (FRANCE, UNITED KINGDOM, AND WEST GERMANY) NATIONAL INTERESTS

Western European countries have maintained transformation economies ever since the days of their extensive empires. Their colonies were the source of cheaply acquired raw materials that could be imported back to the homeland. European industries subsequently produced high value-added finished goods that were exported at considerable profit.

The Western democracies of France, the United Kingdom, and West Germany have national interests similar to those of the United States. All want to avoid technical dependency upon any other country, including other EEC countries.[46] Western European nations have taken strenuous measures to avoid technological dependency in priority industries such as the computer sector, where they have had mixed success.

1. French National Interests

In the United States, some fear the "Japan Inc." effect of Japanese industry and government working together toward a leadership position in the computer field. In France the concern is not so much about Japan as it is about IBM. A report to the President of France in 1980 stated that:

> Once a manufacturer of machines, soon to become a telecommunications administrator, IBM is following a strategy that will enable it to set up a communications network and to control it. When it does, it will encroach upon a traditional sphere of government power, communications. In the absence of a suitable policy, alliances will develop that involve the administrator of the network and the American data banks, to which it will facilitate access.[47]

This statement exemplifies the stakes of communications sovereignty and technological dependency. The overall national interests involved are the maintenance of competition in a domestic market and international

competitiveness, as well as avoiding technological dependency on other countries.

2. U.K. National Interests

The U.K. takes Japan's Fifth Generation Computer Project very seriously and has launched its own program to develop advanced computer technology. The report recommending the establishment of this program stated that it is needed for the United Kingdom to compete in the world, ensure full employment, maximize industrial efficiency, and contribute to the general economic situation. The U.K. also believes that the program is needed to ensure its security. As the report stated, "[r]elying upon overseas sources would leave us dangerously exposed, and be highly prejudicial to our civil and our defense I.T. [Information Technology] industry."[48]

Clearly at stake for the U.K. is the competitiveness of its computer industry, an imperative consistent with its overall national interest of maintaining effective domestic competition and international competitiveness. At issue is whether U.S.-Japan technology is a threat to the Western European economy.

3. West German National Interests

One national interest factor unique to West Germany is the arbitrary division of Germany following World War II. There is considerable trade between West Germany and East Germany where historical trading partner relationships exist. In fact, West Germany has the largest volume of trade with the Soviet Bloc of any Western country. Like France and the United Kingdom, West Germany is engaged in efforts to improve its technology in the information industry with an eye on both the United States and Japan. Siemens, a major computer manufacturer in

West Germany, recently formed a joint research institute with Compagnie de Machines Bull from France and I.C.L. from the U.K. to coordinate their activities at a pre-competitive level in the area of knowledge processing technology. At stake is the competitiveness of European computer industries. The overall national interest involved is maintaining international competitiveness as well as maintaining competition in the domestic market.

4. European Economic Community Interests

The Western European nations are also collectively concerned about technological dependence on the United States and Japan. Assessing its position compared with the two world leaders, the Commission of the European Communities concluded that Europe has lagged behind in the industrial application of many high technologies and notably electronics.[49] In response the EEC has launched the ESPRIT program, a community effort to develop advanced computer and information technology.

In conclusion, it can be said that the three major Western European states' national interests are mutual and similar to those of the United States. Nevertheless, there are three important exceptions: Western Europe's historical interests in improving their economic position in the world based on a transformation economy, maintaining a historical trading relationship with Eastern Europe (pertains primarily to West Germany), and avoiding technological dependency on other countries.

E. SUMMARY

A review of the national interests and objectives of the United States, Japan, and the three major Western European nations reveals a complex web of interrelated national interests, stakeholders, issues,

and questions relating to technology transfer. As respective competitive positions, national security threats, and related factors evolve, the questions and issues will change and demand new policies and actions. This flexibility can be viewed as a positive factor, but it can also cause problems, such as the allies' concern over the use of technology transfer for political purposes or other instances of perceived inconsistency in policy. These concerns could lead to such responses as the U.S. allies' autonomously developing their own technology.

The many long-range objectives and national interests affected by technology transfer policies may appear as a complex and confusing set of relationships. On the other hand, the national interest perspective offers a framework for evaluating the effectiveness of an existing policy or the implications of policy options.

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IV. IMPLICATIONS FOR POLICIES

This analysis has focused on two fundamental challenges: 1) how to accommodate politically the government and business interests affected by or affecting technology transfer in order to devise technology transfer policies in the overall national interest, and 2) how to ensure that the policies and institutions of the U.S. government and business communities are effectively organized to deal with U.S.-Japan technology transfer and its effects.

We have looked at the transfer of technology between the U.S. and Japan, with particular emphasis on computer and computer software technology. This chapter will evaluate a cross-section of policies proposed in response to these two questions to gain further insight into possible implications of pursuing individual or collective policy options.

A. EXAMPLE POLICY OPTIONS -- CONSIDERING THE EFFECTS ON THE NATIONAL INTEREST

The President of the United States is elected to represent and consider the overall national interest in developing, deciding among, and executing policies. Congress members may have their individual constituencies, but are expected to consider what is also in the national interest in carrying out their responsibilities in enacting legislation. Officials in policy making positions in the executive branch are similarly expected to have a sense of national interest in proposing and executing policies.

Because the national interests (see Chapter III) should be considered by the President and other national policymakers when weighing various policy proposals and options, it is useful to identify the relationships between national interests and various policy options.

An appraisal of the influence of policy options on the national interest can be made on the basis of a few representative policy proposals of the stakeholders, administrators and others (see Chapter II). Ideally, this analysis would include a provision for criteria and the assignment of weights by the policymakers to evaluate the various policy options individually and in the aggregate. In lieu of criteria, weights, and policymakers' participation, we can develop policy implications by using certain assumptions.[1]

Table F portrays a sample of national interests on one axis and some example policy options of proposals along the other. When some assumptions are included, it is possible to see the effect of these options on different national interests. The pages that follow explain Table F and some of its implications. Again, these are only examples of policy options, and by no means constitute an exhaustive list of all the proposals that have been made.

Example Options	Economic Interests				National Security Interests		Foreign Policy:	Scientific, Cultural and Humanitarian	
	I.a. Income Growth	I.b. Full Employment	I.c. Maintain Competition	I.g. Fair, Free & Balanced Trade	II.a. Minimize Capabilities of Enemies	II.b. Increase Capabilities of Allies	III.a. Cooperation with Other Countries	IV.a. Advance Science & Technology	IV.b. Aid Lesser Developed Countries
1.a. Make it easier to prove availability	+		+	+	-				
1.b. Eliminate or reduce foreign availability	-		-	-	+				
2.a. Dept. of Commerce retains primary responsibility	+		+	+	-				
2.b. Increased role for DoD	-		-	-	+				
2.c. Office of Strategic Trade given primary responsibility	?		?	?	?				
3.a. Narrow the definition of technology to control	+		+	+	-				
3.b. Present control restrictions	+		+	+	-				
3.c. Broaden definitions of technologies to control	-		-	-	+				

Legend: "+" Option may have a positive effect on national interest.
"-" Option may have a negative effect.
"?" Effect is uncertain.

Table F

Effect of Policy Options on Selected National Interests

Example Options	Economic Interests				National Security Interests		Foreign Policy:	Scientific, Cultural and Humanitarian	
	I.a. Income Growth	I.b. Full Employment	I.c. Maintain Competition	I.g. Fair, Free & Balanced Trade	II.a. Minimize Capabilities of Enemies	II.b. Increase Capabilities of Allies	III.a. Cooperation with Other Countries	IV.a. Advance Science & Technology	IV.b. Aid Lesser Developed Countries
4.a. U.S. government negotiate access to Japan's market			?	?				?	
4.b. Apply reciprocal barriers to U.S. market			?	?				?	
4.c. Permit Japan to protect its industries			-	-				+	
5.a. Let market set price of technology			?	+					
5.b. Restrict access or raise price of technology			?	-					
6.a. Tighten controls on academic research					+			-	
6.b. Retain present restrictions on academic research					?			?	
6.c. Eliminate restrictions on all but classified research					-			+	

Legend: "+" Option may have a positive effect on national interest.
"-" Option may have a negative effect.
"?" Effect is uncertain.

Table F, continued

Example Options	Economic Interests				National Security Interests		Foreign Policy:	Scientific, Cultural and Humanitarian.	
	I.a. Income Growth	I.b. Full Employment	I.c. Maintain Competition	I.g. Fair, Free & Balanced Trade	II.a. Minimize Capabilities of Enemies	II.b. Increase Capabilities of Allies	III.a. Cooperation with Other Countries	IV.a. Advance Science & Technology	IV.b. Aid Lesser Developed Countries
7.a. Government support of R & D	+	+	+	+			?	+	
7.b. Adopt legislation to foster environment for R & D	+	+	+	+			?	+	
7.c. Laissez-faire	?	?	?	-			+	?	
7.d. Protectionist measures	-	-	-	-			-	?	
8.a. Unilateral use of technology transfer as foreign policy tool			-				-		
8.b. Require consultation with other countries before use as foreign policy tool			+				+		
9.a. Do not transfer technology unless full employment	?	+						-	-
9.b. Export technology regardless of full employment	?	-						+	+

Legend: "+" Option may have a positive effect on national interest.
"-" Option may have a negative effect.
"?" Effect is uncertain.

Table F, continued

Example Options	Economic Interests				National Security Interests		Foreign Policy:	Scientific, Cultural and Humanitarian	
	I.a. Income Growth	I.b. Full Employment	I.c. Maintain Competition	I.g. Fair, Free & Balanced Trade	II.a. Minimize Capabilities of Enemies	II.b. Increase Capabilities of Allies	III.a. Cooperation with Other Countries	IV.a. Advance Science & Technology	IV.b. Aid Lesser Developed Countries
10.a. Continue to blackbox critical technology to allies			?		?	-	?	-	
10.b. Transfer technology on basis of reciprocity and adequate protection			-		?	+	+	+	
11.a. Primary enforcement responsibility to Customs Service			-	-	+				
11.b. Divide responsibilities between Customs and Commerce			?	?	-				
12.a. Apply sanctions against allies who violate COCOM controls					+		-		
12.b. Rely on negotiation and persuasion to influence COCOM allies					?		+		

Legend: "+" Option may have a positive effect on national interest.
"-" Option may have a negative effect.
"?" Effect is uncertain.

Table F, continued

Example Options	Economic Interests				National Security Interests		Foreign Policy:	Scientific, Cultural and Humanitarian	
	I.a. Income Growth	I.b. Full Employment	I.e. Maintain Competition	I.g. Fair, Free & Balanced Trade	II.a. Minimize Capabilities of Enemies	II.b. Increase Capabilities of Allies	III.a. Cooperation with Other Countries	IV.a. Advance Science & Technology	IV.b. Aid Lesser Developed Countries
13a. Establish a Department of International Trade and Industry			+	+	?		?		+
13b. Maintain present division of international trade responsibilities in Executive Branch			?	?	?		?		?
13.c. Establish White House level coordinating body			+	+	+		+		+
14.a. Continue present R & D legislative framework			?					?	
14.b. Adopt legislation to remove R & D joint venture risks			+					+	
15.a. Continue with current competition framework			+?		+		?		
15.b. Establish a cooperative venture with Japan			??		-		+		

Legend: "+" Option may have a positive effect on national interest.
"-" Option may have a negative effect.
"?" Effect is uncertain.

Table F, continued

Example 1. Foreign availability. A critical factor to the stakeholders in technology transfer is foreign availability, i.e., other countries that might be willing to make such technology available to an adversary. If one assumes that in a given situation the U.S. is not the sole possessor of a technology coveted by its adversaries, then at least two policy options can be considered:

1. making it easier to prove foreign availability, as did the 1983 House Foreign Affairs Committee Report on the bill to amend the Export Administration Act of 1979,[2] or

2. eliminating or reducing the influence of foreign availability as a reason for granting a license to export.

The first option, better means of proving foreign availability, might have a positive effect on U.S. economic interests if they were allowed to transfer technology available elsewhere. However, it might have a negative effect on U.S. efforts to reduce the offensive military capability of U.S. adversaries, if it facilitated their acquisition of the technology they sought. Eliminating or reducing foreign availability as a factor in the course of export licensing could have the opposite effect.

Example 2. Commerce or DoD -- first among equals. The previous chapter's discussion of the respective roles of the Department of Commerce and Department of Defense provides a good example of the difficult policy balancing required by technology transfer. Assuming that the Soviet Union gains from Western technology, and that tighter controls could significantly reduce their acquisition efforts, responsibility for licensing technology for export could be assigned at least three ways:

1. the Department of Commerce could retain the primary responsibility,

2. the Department of Commerce could retain its present role, but with an increased role given to the Department of Defense, or

3. an independent agency such as the proposed Office of Strategic Trade could be given the primary responsibility, as laid out in a 1983 bill authored by Senator Garn and others.[3]

Giving increased responsibility to the Department of Defense by institutionalizing DOD's export control functions under legislative mandate (as proposed in 1983 by the Senate Banking Committee) might have a positive effect on national security.[4] Giving the responsibility to the Department of Commerce might favor economic objectives. It is unclear how giving the responsibility to an Office of Strategic Trade would affect national security or economic interests.

Example 3. Loosen or tighten controls? Technology that can be used for both commercial and military purposes poses very difficult problems in formulating balanced policies that uphold both national security and economic interests. The Computer Business and Equipment Manufacturers Association has told Congress that it wants to avoid "to the maximum extent possible" controls on such technologies.[5] Once again assuming that the U.S. is not the only country where this technology is available, there are at least three possible options:

1. narrowing the definition of technology to be controlled to exclude more dual use technology,

2. maintaining the present control restrictions, or

3. broadening the definitions of the technologies to be controlled to include dual use technologies and those that could be conceivably modified for military purposes.

While broadening the definitions (and thus increasing the amount of technology controlled) might help minimize the offensive military capabilities of U.S. adversaries, it would more than likely have a negative effect on economic objectives. Conversely, to maintain the present definitions or to exclude dual use technology from control might risk national security at the expense of economic interests.

Example 4. Gaining market access. Economic and national security are often the interests that must be traded off to achieve a sound policy balance. But there are also times when one economic interest must be traded off against others or against the worldwide advancement of science and technology.

Players in the U.S. have questioned the fairness of the economic game, often referring to the inaccessibility of Japanese markets. Those who think the U.S. competitive situation is threatened have been seeking a more equitable trade relationship with the Japanese. It is thought that some governmental action could be effective in gaining access to the Japanese market. At least three options should be considered:

1. the U.S. government could negotiate on the behalf of business for access to the Japanese market,

2. the U.S. government could apply recipocal barriers to the U.S. market such as sanctions or protective measures if Japan declines to open its markets, or

3. the U.S. could permit Japan to protect its industries.

Options 1 and 2 are similar to a 1982 bill sponsored by Senator

Danforth requiring the United States to demand "fair and equitable" market opportunities before considering reciprocal barriers in the U.S.[6] While the third option might cause some harm to U.S. economic objectives, it could have an indirectly positive influence on the worldwide advancement of science and technology. If "infant industries" were allowed protection in Japan, their revenues could be used to develop the technology and critical mass necessary to move into the international trade arena. This argument would have little support, of course, if the Japanese continued to protect industries that were viable international traders, further threatening the competitiveness of U.S. companies.

Example 5. What price technology? As pointed out in Chapter III, Control Data Corporation's Chairman William Norris was one of those who questioned whether transferred technology receives fair value. That conjecture assumes that the U.S. competitive position is threatened because the U.S. is making its technology available too freely, and secondly, that the marketplace is capable of setting a fair price for technology. Accordingly, there are at least two options:

1. letting the market set the price of the technology, or

2. restricting access to or raising the price of the technology.

Allowing the market to set the value for the technology might be in consonance with fair and free trade, but it is not clear whether this would improve the U.S. competitive position. Some would view restricting access to the technology as a trade obstruction because of the artificial barrier that has been introduced. The impact of this option on the U.S. competitive position is also uncertain. As some observers have pointed out, technology that is restricted for either national security or economic reasons can impel a country to develop its

own technological capability.[7] With their own home-grown capability they could conceivably become a competitor to contend with.

Example 6. Controls that affect academic freedom. The application of controls on military-critical technology in the academic environment is always controversial. Assuming that the academic community continues to engage in research on military-critical technology, that the leading academic institutions would agree to controls on their research, and that the U.S. leads in a given technology area, one might consider at least three options:

1. tightening controls on academic research that would exclude the participation of foreign nationals, institute mandatory pre-publication review, and monitor any "sensitive" or classified research;

2. retaining the present restrictions on academic research except for adding a small "grey area" of research activities for which limited restrictions short of classification might be appropriate, as proposed by the National Academy of Sciences;[8] and

3. eliminating restrictions on all but classified research.

While tightening controls might minimize national security risks, it would hamper the advancement of science and technology according to the stakeholders.[9] The efficacy of retaining the present controls is uncertain even if a "grey area" could be readily defined and added to existing controls. Advocates of tighter controls believe that eliminating controls for all but classified research would risk national security. On the other hand, the scientific community would be quick to point out that allowing technology to flow more freely contributes to the advancement of science and technology.

Example 7. To strengthen U.S. economic and scientific offense or defense. One of the most highly debated questions is whether Japan will strongly challenge the U.S. in the computer area and what the U.S. response might be. Assuming that the U.S. competitive position is threatened and that some sort of government action is appropriate leads to at least four options to consider:

1. increasing government support of research and development in areas that might ensure U.S. leadership in a certain technology (such as the Defense Advanced Research Project Agency's supporting artificial intelligence),

2. adopting legislation to improve the environment for fostering and developing technology (as a Republican task force in the House has proposed)[10],

3. following a laissez-faire approach that might allow the Japanese either to maintain their present competitive position or to gain a position of leadership, and finally

4. adopting protectionist measures such as quotas, tariffs, or other barriers to trade.

While the first two options involving government action might have a positive effect on economic objectives, the effect on the overall bilateral relationship is unclear. The outcome would depend upon Japan's response to the U.S.' political initiative. At the same time, such positive actions are likely to contribute to the advancement of science and technology. The laissez-faire option risks an unfavorable balance of trade, even though it might have a positive effect on the political relationship. U.S. political leaders usually frown upon the more controversial protectionist measures. While protectionism may have

a short-term positive effect on economic objectives, it is generally thought to have a long-term negative effect. Also, protectionism can harm the bilateral relationship and can lead to "trade wars."

Example 8. A foreign policy tool? The use of technology transfer as a U.S. foreign policy tool against military adversaries or other countries with whom there are political or humanitarian differences has troubled U.S. allies. Some believe this has hindered NATO unity as well as U.S. competitiveness. (See Chapters II and III.) There are two clear options if the U.S. is the sole possessor of a given technology:

1. continuing to use technology transfer as a foreign policy tool unilaterally, or

2. requiring consultation with other countries before using technology transfer as a foreign policy tool, as proposed in the amendments to the Export Administration Act.[11]

In the event that U.S. allies also have the technology and also agree to transfer restrictions, the second option may not adversely affect U.S. economic interests or relationships with U.S. allies. Using technology transfer as a foreign policy tool without allied agreement risks failing on all counts: the intended foreign policy goals, U.S. economic competitiveness, and the relationship with allies. It should also be noted that both the Senate and House proposals for amending the Export Administration Act call for consultation with Congress before use of technology as a foreign policy tool -- reflecting Congressional dissatisfaction with its past use by the executive branch.

Example 9. Effect on workers' rights. Organized labor has proposed that technology not be transferred out of the U.S. when such exporting conflicts with full employment goals.[12] While the labor

sector might benefit from this approach if the U.S. entered a period of significant unemployment or workforce immobility, the policy might have a mixed effect on the goal of increased income as well as erode the profits businesses could gain from the sale of technology. Labor's proposal might also slow down worldwide advancement of science and technology, and impact U.S. goals of aiding lesser developed countries.

Example 10. Recycled technology. Chapter III noted that the U.S. has often black-boxed critical technology in trade or coproduction arrangements with its allies. The specific U.S. objectives in blackboxing its most sensitive technology cannot be verified. It is probably reasonable to surmise that the national security objectives include minimizing the chances that the technology might be misused or that it might fall into the hands of a real or potential adversary. In a case where the U.S. is the sole possessor of a technology sought by its adversaries, there are two key options:

1. continuing to black-box critical technology provided to allies like Japan, or

2. transfering critical technology to allies on the basis of reciprocity and the provision of adequate protective measures.

Continued black-boxing of technology would probably reduce the chances of U.S. adversaries acquiring military-critical technology, but it might also deter the development of defensive capabilities of an ally such as Japan. Japan would continue to rely upon the U.S. for the manufacturing know-how unless it could acquire the technology independently. Black-boxing could conceivably retard the advancement of science and technology overall since Japan might be unable to make a significant contribution to the advancement of technology.

There is the possibility that continuing to black-box technology to Japan might harm the political relationship with a staunch ally. This option could even have some unintended economic effects. For example, Chapter III discussed how three Japanese computer electronic firms decided to develop their own technology in lieu of relying on U.S. black-box systems for their front line fighter aircraft. In the long run, this kind of reaction could find Japan developing its own technology and becoming a strong competitor to U.S. business.

Openly transferring the technology to an ally like Japan, provided there would be some reciprocal exchange and adequate protections, might impact U.S. competitiveness if diverted to Japanese commercial uses. At the same time, this option might increase the technological capability of an ally, enhance the bilateral relationship, and contribute to the advancement of science and technology.

Example 11. The question of enforcement. In 1983 the Senate Banking Committee proposed giving the U.S. Customs Service primary enforcement responsibility for technology transfer control. An alternative is the present division of enforcement responsibilities between the Department of Commerce and the Customs Service -- limiting Customs to pre-seizure activities.[13] The assumption behind the first proposal is that Customs has long tradition and experience in the enforcement area and can do a more efficient and effective job in enforcing controls on technology than can Commerce. To make Customs responsible for the enforcement of technology transfer might improve enforcement of technology transfer controls. On the other hand, those favoring Commerce in the primary enforcement role argue that "Customs lacks the technical expertise . . . to make determinations on a whole range of items that

are destined for the export market."[14] If this is the case, giving Customs primary enforcement responsibility could adversely affect economic interests such as balance of trade and U.S. competitiveness.

Example 12. Cooperation or sanctions. A key foreign policy question is whether there is sufficient cooperation within the COCOM framework regarding technology transfer. Assuming that U.S. allies are also possessors of the technology targeted by U.S. adversaries, sanctions against U.S. allies who do not tightly control the flow of technology may be a possible solution.[15] This option is in contrast to the present policy of persuasion and negotiation in the face of inadequate allied control of technology. While applying sanctions might better protect valuable technology, it might also negatively affect foreign policy and the bilateral relationship with allies such as Japan. At present, it is not clear how effectively the current policy of negotiation deters U.S. adversaries from gaining control of technology they seek. Nevertheless, it is argued that reliance on negotiations and persuasion is consistent with foreign policy objectives.

Example 13. Reorganization in the executive branch. In light of the projected escalation of competition with Japan and Western Europe in the coming decades, Senator Roth proposed the establishment of a Department of International Trade and Industry within the executive branch to serve future U.S. economic interests.[16] An alternative would be to maintain the present division of responsibilities on matters relating to international trade among the Department of Commerce, the Office of the Special Trade Representative, the Department of Treasury, Department of Agriculture, Department of Labor, Department of Defense, and Department of Justice, as well as other independent agencies and

commissions. A third alternative, propounded by MCC President B.R. Inman, Robert Reich, and others, would be to establish some new organization above the Cabinet level for this purpose, possibly similar to the National Security Council or a component of the National Security Council.[17]

Assuming that the U.S. competitive position is threatened and that there is no acceptable compensating trade advantage for the United States, each of the three options has different potential effects on the national interest. A Department of International Trade and Industry might help maintain U.S. international competitiveness, help achieve a favorable balance of trade, and might help realize planned technological change. On the other hand, it is not clear that creating such a department will have any national security benefits or foreign policy benefits. Creating an international trade component of the National Security Council might further national security and foreign policy objectives since that option is conducive to a higher level of coordination than can be achieved by departments that are equals. This would also allow trade-off decisions between national interests to be made by the President when necessary.

Example 14. Removing some of the risks in joint R&D ventures. Assuming that U.S. business research and development efforts would be more productive if collaboration were encouraged, joint research can be pursued in at least two ways:

1. maintaining the present legislative framework, which was designed to prevent monopolies and antitrust practices, or

2. removing the risks joint research efforts are subject to because of the ambiguities in present laws.

For example, one attorney whose practice has been limited to anti-trust litigation advised the companies that intended to form Micro-electronics and Computer Technology Corporation that their contemplated joint venture would be "an unequivocal combination in violation of the antitrust laws of the United States."[18] A bill entitled "The National Productivity and Innovation Act" has been designed to eliminate such ambiguities and risks, and was being considered by Congress during 1984.[19] While this bill may enhance both the U.S. ability to maintain its international competitiveness vis-a-vis Japan and the advancement of U.S. science and technology, continuing under the existing legislative framework would leave both of those objectives in doubt.

Example 15. U.S.-Japanese cooperation in R&D? There are many U.S.-Japanese joint business ventures involving joint ownership, the sharing of products, production, distribution, or marketing facilities. While a growing number of these joint ventures are in the computer industry, few involve research and development of new technologies. Assuming that there would be no irremovable legal obstacles to international joint cooperative efforts in research and development, and that some form of international cooperation would produce otherwise unattainable results, there are two options that could be considered:

1. the United States could continue its competition with Japan at current or escalated levels, or

2. the U.S. could establish some additional joint cooperative effort(s).[20]

Continuing with the current ground rules for competition would help maintain competition within the United States, but it is uncertain how this would affect the overall international competitiveness of United

States industries. The present ground rules would also continue to minimize the military capabilities of actual or potential adversaries because technology transfer would be restricted. There is speculation that some additional U.S.-Japanese cooperative research ventures might aid the advancement of science and technology both within the United States and Japan, albeit at the risk of technology falling into the hands of actual or potential adversaries. Since both the United States and Japan would gain access to the same technology, any changes in the domestic competitiveness of the two countries would depend on how the technology was diffused within each economy.

B. SUMMARY

Choices among policy options are rarely clear-cut. Comparing policy proposals and their potential impacts on U.S. national interest highlights the complexity of determining the best policy mix. For example, it is possible to favor policies that contribute to economic, scientific, technological, and foreign policy interests while having no adverse effect on national security controls of technology.

Achieving the right balance in policies that affect the national interests doesn't always mean giving equal weight to national security policies and economic policies. Applying equal weight to both areas could actually give the Soviets sufficient leverage to close the gap in one or more military-critical technologies. Instead, careful management and high level attention is necessary to guard each area of interest, monitor the present state of technology in both adversarial and allied countries, and make policy decisions in the overall national interest.

A number of technological areas have been suggested as barometers of present U.S.-Japanese competition:

1. Which country is making progress toward providing an environment for developing and using new technology? Is the U.S. overcoming some of its Not Invented Here (NIH) syndrome, and its general resistance to change? Is the U.S. government helping or hindering the development and implementation of new technology by the methods in which it contracts for building new computer systems?[21]

2. Is the U.S. better in the front end of computer systems engineering work and Japan superior in the latter stages of computer systems development? Is Japan getting a handle on the front end of software engineering work?[22] Is Japan also getting a handle on marketing and distribution know-how in the United States?

3. Is there a trend toward cottage industries in Japan or small entrepreneurial concerns?

4. Is there already a degree of software technology transfer from Japan to the U.S. in the form of industrial process control technology?[23] Are there other signs of technology flowing back to the United States?

5. Are Japanese visitors being discouraged from coming to the United States to tour and gather information from U.S. businesses?[24] Has this discouragement become a trend?

In addition to assessing technology and technology transfer status and trends, one must consider progress toward achieving the U.S. national interest. Are policymakers satisfied that Japan has adequately contributed to the defense of its own territory and the surrounding area? Would it be in the U.S. interest for Japan to be an even stronger nation economically than it is now with respect to China or the rest of Asia? And to what extent is the U.S. interested in some kind of a

cooperative arrangement with Japan, either through business or governmental interests in the development of science and technology?

If one assumes that U.S. national interest is furthered by policies that have a positive effect on both economic and national security interests, it is possible to choose such policies even from among the sample presented here. Continuing to black-box technology to Japan, for example, while not contributing to Japanese capabilities, reduces the risk of Soviet acquisition and does not appear to adversely affect economic interests in the short run. The impact becomes more uncertain, however, when one considers independent Japanese development of the same technology. Establishing a National Security Council component for coordinating international trade also seems to favor both national security and economic interest.

The policymaker has difficulty choosing among policy proposals that impact both U.S. and Japanese national interests. Perhaps the remarks of Japanese Prime Minister Nakasone at the 1983 Shimoda Conference best summarize the importance of the U.S.-Japan trade and technology relationship and the need for policies in both the Japanese and U.S. national interest:

> [S]table Japan-U.S. relations are an indispensable prerequisite for conducting Japan's relationship with such nations as the Soviet Union and China. . . .
>
> [I]f Japan and the United States were to start pursuing a protectionist path, there would no longer be any country which could stop this trend. . . .
>
> The advances and development in technologies in the two countries, especially, are quite remarkable, and I believe that development of a mutually stimulative and beneficial relationship between Japan and the United States in this field would become a basic driving force for the world in the twenty-first century.[25]

CHAPTER IV NOTES

1. This method of depicting the effect of various options for U.S. policy proposals and the use of assumptions related to those options is similar to that used in U.S. Congress. Office of Technology Assessment. Technology and East-West: An Update. Washington: GPO, 1983, pp. 12, 87-98.

2. U.S. Congress. House. Committee on Foreign Affairs. Export Administration Amendments Act of 1983, 98th Cong., 1st sess., June 22, 1983, H.R. 3231, p. 18.

3. U.S. Congress. Senate. Committee on Banking, Housing and Urban Affairs. The Export Administration Act Amendments of 1983, Report of the Committee No. 98-170, 98th Cong., 1st sess., p. 1.

4. Ibid, p. 12.

5. U.S. Congress. Senate. Subcommittee on International Finance and Monitary Policy of the Committee on Banking, Housing, and Urban Affairs. Reauthorization of the Export Administration Act, Hearings, 98th Cong., 1st sess., March 2, 16, and April 14, 1983, p. 216.

6. Farnsworth, Clyde H. "Senate Panel Clears Bill That Could Assist Trade," The New York Times, June 17, 1982, p. D1.

7. Interview with Gordon Raisbeck, consultant, Lexington, Ma., April 20, 1984.

8. National Academy of Science. Panel on Scientific Communication and National Security. Committee on Science, Engineering and Public Policy. Scientific Communication and National Security. Washington: National Academy Press, 1982, p. 5.

9. U.S. Congress. House. Committee on Armed Services. Technology Transfer, Hearings, 98th Cong., 1st sess., June 9, 21, 23; July 13, 14, 1983, p. 256.

10. The Steering Committee of the Task Force on High Technology Initiatives, House Republican Research Committee. Targeting the Process of Innovation: An Agenda for U.S. Technological Leadership and Industrial Competitiveness, May 1984.

11. Export Administration Amendments Act of 1983 (see note 2), p. 20.

12. U.S. Congress. House. Subcommittee on Science, Research and Technology of the Committee on Science and Technology and the Task Force on Education and Employment of the Committee on the Budget. Technology and Employment, Joint Hearings, 98th Cong., 1st sess., June 7, 9, 10, 14, 15, 16 and 23, 1983, p. 1242.

13. The Export Administration Act Amendments of 1983, Report of the Committee, No. 98-170, (see note 3), p. 20.

14. Technology Transfer, Hearings, (see note 9), p. 274.

15. The Export Administration Act Amendments of 1983, A Report of the Committee No. 98-170 (see note 3), p. 19.

16. U.S. Congress. Senate. Committee on Governmental Affairs. Trade Reorganization Act of 1983, Hearings. 98th Cong., 1st sess., March 17, 1983, p. 2.

17. Interview with Bobby Inman, President and Chief Executive Officer of Microelectronics and Computer Technology Corporation, Austin, Texas, July 20, 1984; interview with Robert Reich, Harvard University, May 18, 1984.

18. U.S. Congress. House. Subcommittee on Science, Research and Technology of the Committee on Science and Technology. Research and Development Joint Ventures, Hearing, 98th Cong., 1st sess., July 12, 1983, p. 36.

19. Greenhouse, Stephen. "Business and the Law: A Plan to Spur Joint Research," The New York Times, June 26, 1984, p. 30.

20. Michael Dertouzos, Director of the Laboratory for Computer Science at MIT, favors more intense or "tribal competition" with Japan, as he stated in an interview on May 16, 1984. For a proposal on joint cooperative efforts, see U.S. Congress. Joint Economic Committee. Industrial Policy Movement in the United States: Is It the Answer? 98th Cong., 2nd sess., June 8, 1984. Washington: 1984, p. 48.

21. Interview with Winston Royce, Director, Data Systems Engineering, Lockhead, June 28, 1984.

22. Interview with Ralph Walker, Chief, Tactical Systems Group, National Security Agency, Research and Engineering, May 3, 1984.

23. Interview with Barry Boehm, Chief Engineer, Software and Information Systems Division, TRW, June 5, 1984.

24. Ibid.

25. Nakasone, Yasuhiro. "Message from Prime Minister Nakasone," Report of 6th Shimoda Conference 1983. New York: Japan Society, 1983, p. 80.

APPENDIX: THE IMPORTANCE OF COMPUTER SOFTWARE

Computers serve many crucial functions in today's Western society. Banking systems depend upon computers. Military communications and state-of-the-art weapons rely on advanced computer systems. Cultural advances are sometimes based on, or assisted by, computer technology. Computers are more than just hardware capable of processing at high speeds and storing large quantities of data. Computer systems require programs, or software, that form a more friendly interface between the users of the system and the intricate hardware circuitry that tailors the system to perform specific applications.

Software is only part of the story; people are usually interested in purchasing, acquiring, or developing total systems that consist of both hardware and software components. In fact, the decision as to whether to employ software or hardware is often made late in the design stage of system development. And, as one software expert cautions, technology alone will not ensure the successful development of a system; "you've got to have quality staff" which means you have to have a high level of professionalism, "and that's a mixture of approach, discipline, attitudes, management, tools, and techniques."[1] With these caveats, this paper nevertheless emphasizes software because of its growing economic and national security importance.

A characteristic of computer software that distinguishes it from computer hardware is its transportability. Software can take many forms and can be transmitted easily. It is easy to transmit a computer program from a computer in one place in the United States to another over regular dial-up telephone lines in a matter of seconds or minutes depending upon the size of the program to be transferred. This not only

presents a lucrative source for software pirates, but it also presents the U.S. with potential national security problems.

As larger and more complex systems are built, the software component is larger and more complex, making it more valuable and the target of both competitors and adversaries. In terms of national security, certain software has been identified as militarily critical technology, and for good reason. As one industry expert puts it, "software is the Achilles heel of all systems, that is, if I want to gain control of a system and I am an adversary, I go after the weakest link in the system central to control -- the software."[2] Economic interests in software have made it the subject of increasing efforts to protect its proprietary value both domestically and internationally. It is not clear whether it is in the long run practical to protect it as being proprietary. Ironically, as one observer notes, the growing complexity of software may be its best protection.[3] In other words, you may have to be an expert in the technology to pirate the technology and make use of it.

Software's increasing importance is also derived from its tie to hardware. Hardware technology continues to undergo dramatic changes, as witnessed by the revolutionary effects of the transistor and the integrated circuit. And now there are some new revolutionary changes pending. To make further advances in computer power, new architectures are being explored such as massively parallel systems. Parallel architectures will have a major impact on software technology according to players on both sides of the Pacific Ocean.[4]

In 1982, computer sales (less peripheral equipment) was a $26.8 billion business for the U.S. and a $7 billion business for Japan.[5]

Over-the-counter software sales in the U.S. totalled $3.11 billion in 1982. They are projected to grow at a faster pace than hardware -- to a total of $16.8 billion in 1986.[6] And behind this visible software market is a significant hidden industry of software, support software, and maintenance software not shown in the dollar totals.

Computer software products can be grouped in two basic categories: 1) systems software, such as operating systems which control computer resources and support the writing and running of computer programs, and 2) applications software, such as employee payroll software, word processing software, and embedded weapons systems software, all of which perform specific functions. While the U.S. excels in both categories of technology, according to one observer "a lack of applications software is supposed to be the greatest impediment for a further expansion of the market share of the Japanese computer manufacturers."[7] The Japanese Institute for New Generation Computer Technology (ICOT) takes the same view of the importance of software:

> In Japan, the lack of research is particularly noticeable in terms of software and basic theories which therefore deserve special attention [in Japan's Fifth Generation Computer Project]. This aspect is extremely important, because development of hardware technologies, including computer architectures and VLSIs has to advance under guidance from research and development of software and basic theories.[8]

U.S. private industry doesn't appear to be resting on its software laurels. The growing recognition of the importance of software technology is illustrated by the Lockheed example. Lockheed is establishing a Software Technology Center in Austin, Texas. Director Winston Royce has expressed the rationale behind this ambitious project:

> Software will be so important that high level national and corporate interests will impinge on it. At the national level there will be a technology race between our nation and our military and economic competitors, in which computer

> processing resource is the competitive issue. One aspect of this race will be how many logical operations per second can be executed by our nation's computing engines. This will be monitored and reported on a national basis much like freight car loadings are today. However by 1995, that will be only the second most interesting race. Of greater interest will be the total number of error free lines of code produced by the nation's workforce. Maximizing lines of code annually will require: 1. a greater number of programmers, 2. more efficient programmers in terms of correct lines of code written per invested man year, and 3. a greater infusion of error free programmers in the work force.[9]

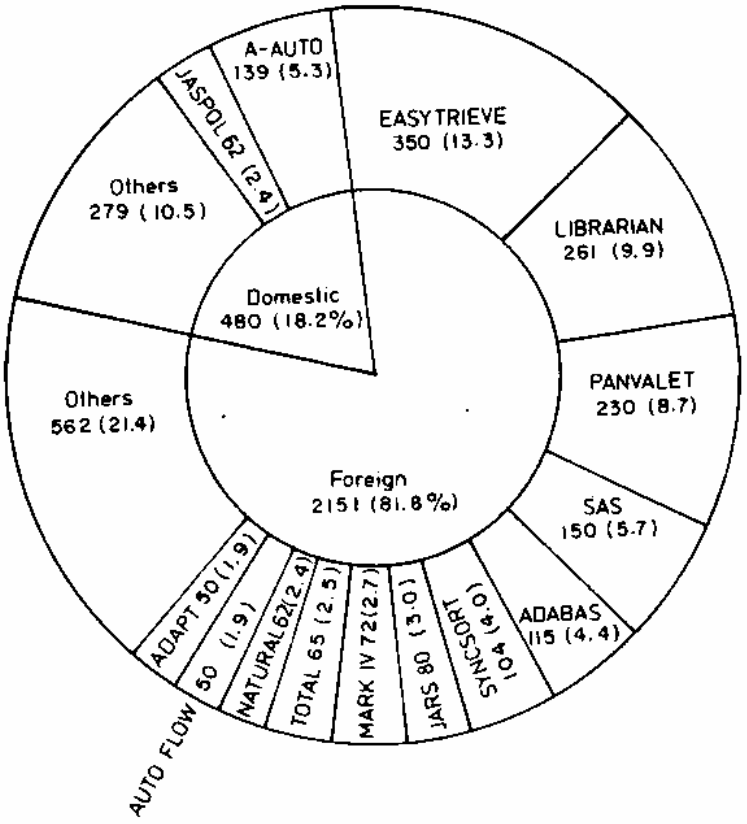
Software technology growth. Two types of software technology figure in this analysis. Product technology is the know-how for designing a particular product, such as an operating system or the queuing algorithm that may be at the heart of communications switching software. Manufacturing process technology, on the other hand, is technology such as the software engineering or life cycle management methods to be used in the production and integration of software modules into a total software system, an operating system, or even a payroll computer program.

1. Product Technology

IBM has the major share of the world's computer market, with reportedly 50-60%.[10] IBM's success has been attributed to its marketing strategies as well as to its hardware and software technology strategies. Today, IBM computer program instructions are a virtual worldwide standard for the industry. This resulted from a decision made more than 20 years ago by the company when the IBM System 360 was introduced. The computer not only incorporated modern solid logic hardware technology, "it was the first 'family' of computers -- ranging from small to large -- that were both upward and downward compatible, using the same programming instructions."[11] Today some of Japan's

largest computer manufacturers owe their success in part to their systems' compatibility with IBM software.

Figure 2. shows that Japanese domestic software manufacturers account for only a relatively small portion of their own software market. Foreign manufacturers, chiefly in the U.S., clearly have the major share with products such as EASYTRIEVE, SAS, ADABAS, SYNSCORT, and TOTAL.



Source: Tajima, Denji and Tomoo Matsubra, "Inside the Japanese Software Industry," Computer 17 (March 1984):34. © 1984 IEEE. Reprinted with permission.

Figure 2

Japanese Market Share of General-Purpose Software

It should be noted, however, that the U.S. cannot claim credit for all significant software product technology. For example, Western Europe is the source of ADA, a modern programming language that is being promoted by the U.S. Department of Defense, and PROLOG, a software language that has been used in expert systems that are usually considered to be a subset of artificial intelligence technology.

Is Japan closing the computer product technology gap? Hearings held during 1983 both in the U.S. House of Representatives and in the Senate on the subject of supercomputers and the machine tool industry, respectively, suggested that Japan may be closing the computer technology gap. Table G compares the historical lead-times and status of many important nations in computer technology. Although the Soviet Union has made a concerted effort to acquire Western computer technology, the table shows that it lags behind. On the other hand, Japan has made great strides in becoming a major factor in the computer industry. (As used here, the computer industry includes R&D and production of electronic components; R&D and production of hardware, i.e., computer mainframe and peripheral equipment; and development and production of operational software.)[12] It took Japan only two years to go from its first working model computer to commercialization. Japan is the only major worldwide competitor of the U.S.

Nation	First Working Model	First Commercialization	Technological Status	Market Position
United States	1946	1951-52	Dominant	Worldwide
Canada	1955	1964	Minor	Domestic
U.K.	1949	1953	Minor	Domestic
West Germany	1941	1954	Minor	Domestic
France	1952	1957	Minor	Domestic
Netherlands	1956	1957	Minor	Domestic
Italy	1957	1960	Minor	Domestic
Sweden	1950	1962	Minor	--
Denmark	1957	1962	Minor	--
Belgium	1960	1963	Minor	--
Austria	1959	--	--	--
Switzerland	1956	--	--	--
Australia	1954	--	--	--
U.S.S.R.	1953	1958	Minor	East. Bloc
East Germany	1955	1964	Minor	East. Bloc
Poland	1959	1965	Minor	East. Bloc
China	1958	1966	Minor	Domestic
Japan	1957	1959	Major	Worldwide

Source: U.S. Congress. House. Committee on Science and Technology. Supercomputers, Hearings, 98th Cong., 1st sess., November 15, 16, 1984, p. 41.

Table G

Historical Lead-Times and 1983 Status in the Computer Industry
By Selected Nations

Japan's Ministry of International Trade and Industry (MITI) has played an important role in a number of Japanese efforts to acquire technology and advance the state-of-the-art in Japanese industry. Professor Susumu Kuno of Harvard University told this researcher of his joint work with Professor Anthony G. Oettinger in the early 1960s to develop a large complex computer software system for parsing English sentences.[13] He developed, tested, and documented the system but did not pursue further improvements because of conflicting interests. Since the software had been written to run on IBM mainframe computers, he deposited the most recent version of the system with SHARE, the IBM-approved users group.

In the early 1980s MITI learned of Kuno's work and wanted to use it in the development of a system MITI was promoting to translate English text into Japanese. Kuno was willing to help but late in 1982 he encountered problems in getting a copy of the grammar and dictionary tapes. Undaunted, the MITI people simply reproduced the grammar and dictionary tapes from the printout and reprogrammed the whole system based on the detailed documentation of the system. Despite the system's size (involving some 3000 rules of syntax) and the complexity of the parsing algorithm, they developed their own new parsing algorithm, and improved the efficiency of the system to a great extent.[14]

One of the most significant Japanese breakthroughs in recent years is in the area of supercomputers, where existing technology is being exploited to the fullest and very efficient FORTRAN compiler software has been developed. Japan also has a major share of the world's machine tool industry and robotics industry, and both use software extensively. If one looks at the statistics on machine tools in the U.S., one sees that from the mid-1960s to 1980 U.S. machine tool imports grew from 4% to 25%. Over the same period, Japan's exports of machine tools increased dramatically, most noticeably in numerically controlled machine tools that grew in value from 1 billion yen to 173 billion yen.[15] By mid-1984 there were reports of some Congressional leaders calling for restrictions on machine tool imports to the U.S.[16]

The transfer of product technology from the U.S. to Japan has contributed to Japan's improved position in computer software markets. NEC Corporation is a Japanese manufacturer of products that bear significant resemblance to those of two U.S. companies: Western Electric Corp. and Honeywell. Also a major supplier of NTT, NEC was established as a joint venture with Western Electric Corporation of the U.S. in 1899. After World War II, NEC began to advance in the field of telecommunications. When NTT was created in 1952, NEC's former president was appointed to head NTT and "that was the beginning of the intimate relationship between NEC and NTT."[17]

In the 1960s NEC made a crucial strategic decision, the results of which are still being seen:

> In the mid-1960's, NTT began development of data communications under its fourth 5-year plan. As part of that work, it decided to build its own DIPS computer, and requested the cooperation of Fujitsu, Hitachi and NEC.

> Fujitsu, Hitachi and NEC had sharply divided views on the development of DIPS.
>
> Fujitsu and Hitachi argued . . . . [that] unless a computer could be developed with price and performance superiority which could compete with IBM, Japan's computer industry could clearly be trampled under by IBM, just as the industry in the European countries was. . . .
>
> NEC countered with the following argument: The computers to be developed under MITI's large project [to develop a computer designed to compete with IBM] and the DIPS project were completely different in nature; combining them would be impossible. NEC would never yield in its insistence that the two projects be pursued independently. . . .
>
> Consequently, Fujitsu and Hitachi formed a group and began development of an IBM-compatible computer. NEC, on the other hand, chose the course of noncompatibility with IBM.[18]

NEC lost no time in acquiring the technology to pursue its plan of action:

> In 1962, NEC concluded a technology cooperation agreement with Honeywell to introduce the Minneapolis based company's then advanced computer technology. Although the contract expired in 1979 the two companies have been cooperating closely in the computer field.[19]

In 1983 it was announced that Honeywell will be marketing NEC's very large scale mainframe computer, the ACOS System 1000.[20] The ACOS series computer is equipped with either of two operating systems:

- ACOS-4, a very advanced system developed independently by NEC, or
- ACOS-6, an advanced operating system which was developed by NEC and has an upward compatibility from GCOS. (GCOS was originally developed by General Electric. Honeywell subsequently bought GE's computer business and further improved GCOS).[21]

Because of a series of Japanese government and business strategies and other factors, NEC has gone full circle from acquisition of U.S. computer software technology to exporting computer software technology to the U.S.

2. Process Technology

Successful application of manufacturing process technology in software development and production has also contributed to Japan's position. In 1981, Professor K. H. Kim of the University of South Florida surveyed Japan's development of software engineering technology (a major component of software manufacturing technology) and found many instances of technology that had originated in the U.S. One example he cited was the use of UNIX, an operating system developed by Bell Laboratories, which is capable of providing an on-line environment for developing computer programs. He also noted use of IBM-developed HIPO, a method for specifying and documenting a method for the hierarchy of software in an information system. Professor Kim wrote that:

> Observations made during and after the trip in no way indicate that the U.S. has lost its technological edge in software engineering. The U.S. still invests considerably more than Japan in R&D of new software engineering technologies. Utilization of these technologies may be a different matter, however.[22]

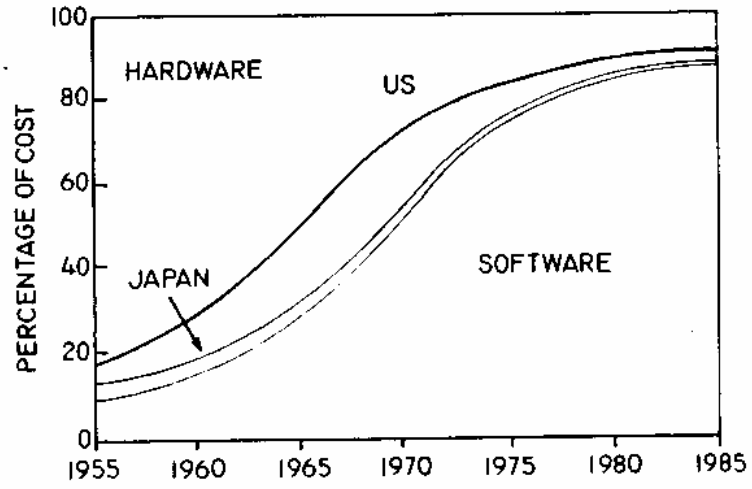
In 1981 IBM asked the University of Maryland to conduct a study of software engineering tools and practices in the U.S. and Japan.[23] The following highlights the comparison with the earlier Kim study:

> Unlike the recent survey by Kim which emphasized the integrated tool sets and artificial intelligence technologies being employed by Japanese industry, we found the level of technology used by the Japanese to be similar to U.S. practices, but with some important differences. . . . [W]e found that Japanese companies typically optimize resources across the company rather than within a single project. . . . [T]ool development and use is more widespread in Japan. Our survey does reinforce some of the conclusions of the earlier survey, namely:
>
> (1) Japanese often use techniques developed in the U.S. or Europe;
>
> (2) Emphasis seems to be on practical tools.

> Two successful techniques used by the Japanese are keeping projects small and relating failures to their causes through postmortem analyses of error data.[24]

Japan's ability to effectively apply U.S. and European software engineering and life cycle management technology has been noted by many computer industry authorities. In 1984, one observer reported that "the average journeyman programmer in Japan is closer to the state-of-the-art than the average journeyman programmer in the bowels of DOD."[25] Reflecting on his study of the Japanese computer industry that included visits to Japanese computer manufacturers, another observer concluded that "they have specialized in the process. They are the best damn process managers of anybody I've seen."[26]

The economic significance of software engineering technology may help explain Japan's interest and success in applying software technology and practices. For several years there has been much talk about the so-called "software crisis." Yukio Mizuno, Senior Vice President and Director of NEC Corporation, wrote in 1983 about the nature of the crisis and how his company is responding. Figure 3 is a chart originally prepared by Barry Boehm of TRW showing the relative cost trends in hardware and software. Mizuno has added Japanese trend data to the chart.



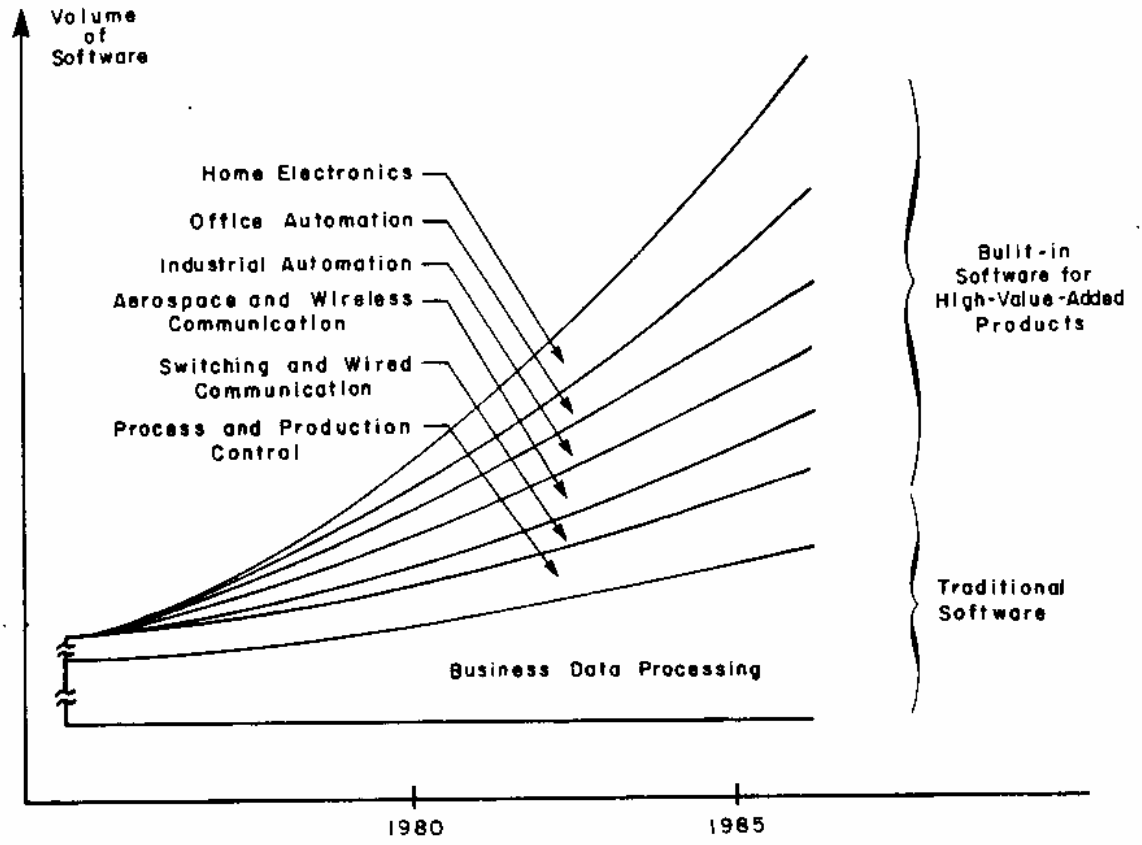
Source: Mizuno, Yukio. "Software Quality Improvement," Computer 16 (March 1983):66. © 1984 IEEE. Reprinted with permission.

Figure 3

Japanese and U.S. Hardware and Software Cost Trends

As Figure 3 shows, software is becoming an increasingly important factor in both the U.S. and Japan in terms of development costs. This is because software development is people intensive. On the other hand, the cost of hardware is falling because of dramatic improvements in circuitry technology. Mizuno notes that software maintenance costs are rising even faster than development costs.

Demand for software is also increasing rapidly, as illustrated in Figure 4. Mizuno points out that this dramatic upward trend is largely attributable to the accelerating and "expanding development of systems that integrate computers and communications."[27]



Source: Mizuno, Yukio. "Software Quality Improvements," Computer 16 (March 1983):66. © 1984 IEEE. Reprinted with permission.

Figure 4

Trends in Software Demand

Mizuno believes that improved quality and reliability of software will be necessary in order to meet the increasing demand. These improvements will require application of software manufacturing process and software engineering technologies.

Ian Ross, President of Bell Laboratories, shares the view that process technology is an important factor:

> Although we have learned, painfully at times, how to produce complex software systems of high reliability, costs have been high. If we are to continue progress in software development, and at the same time bring costs down,

> fundamentally different ways of designing and developing software systems are needed. This is not a problem unique to telecommunications, but applies to all systems employing computers. And such systems are being rapidly deployed throughout our society.[28]

Although much public attention regarding Japan's Fifth Generation Computer Project has focused on the goal of furthering artificial intelligence technology, one of the project's primary objectives is "realization of supporting environments for resolving the 'software crisis' and enhancing software production."[29]

National security interests have also prompted an examination of computer software manufacturing process technology, a component of overall software life cycle management. In 1976 Texas Instruments President J. Fred Bucy headed a Department of Defense task force concerned with controlling the flow of technology to U.S. adversaries. This task force pointed out that the important technology to control was not product technology, but manufacturing know-how. In 1981 there was a follow-on study to the Bucy Task Force by a task subgroup that focused specifically on software technology. That study concluded:

> The military utility of life-cycle management technology is very high. Any large defense system which the adversaries might wish to build requires a knowledge of this technology. Furthermore, the experience gained in building a seemingly innocuous system (e.g., a medical sensor system, which handles multiple real-time inputs) can be applied in an entirely different context. Since adversary experience with this technology is somewhat limited, its criticality is also quite high. Therefore, the control of the export of lifecycle management technology is considered of prime importance by the software subgroup.[30]

The software subgroup of the Computer Technical Working Group also recommended the addition of eight software technologies to the Military Critical Technologies List (MCTL):

1. Software Life-Cycle Management Technology
2. Software Library Data Base

3. Software Development Tools
4. Maintenance of Large Software Products
5. Formal Methods and Tools for Developing Trusted Software
6. Secure Software
7. Large Self-Adapting Software Systems
8. Commercial Software Integral to Critical Military Systems[31]

This comprehensive list includes broad descriptions of the most instrumental factors in the development of both military and commercial computer software systems. Anything resembling this list in a final MCTL would have to be of concern to not only U.S. adversaries but U.S. allies and software manufacturers as well.

Barry Boehm has analyzed the importance of software engineering technology within both the business and military sectors. He states that "the major technological concern confronting us in the 1980's is this serious and rapidly widening gap between the demand for software and our ability to supply it."[32] Boehm explains the gap as follows:

> [T]he national demand for software is rising by at least 12% per year, while the supply of people who produce software is increasing about 4% per year, and the productivity of those software producers is increasing at about 4% per year; this leaves a cumulative 4% gap.[33]

Boehm contends that software engineering initiatives, including those being proposed by the Department of Defense, are vital in order to meet the software needs of the 1990s:

> While we believe that no new technological breakthroughs will be needed to accomplish the improvements we seek, achieving organizational breakthroughs will be essential. Such organizational breakthroughs must succeed in collecting and integrating tools and providing integrated support for software practices of proven effectiveness.[34]

Many computer software experts in U.S. government and industry share Boehm's advocacy of integrating tools and integrated support for software engineering. While there are many automated tools that can aid

the software development process, the integration of these tools leaves much to be desired. In Norman Glick's words, "What we would really like is a requirements language on-line which produces something that will feed directly into a design tool" feeding all the way down to compilers, automatic test generators, maintenance tools, etc.[35]

Why doesn't the U.S. push ahead faster in the development and implementation of software engineering tools and practices? The cost of developing and using some of these tools is a major factor. Winston Royce, a software expert at Lockheed and an advocate of rapid prototyping for software development, cites cost as a major reason for not employing rapid prototyping technology.[36] He notes, however, that the costs should be coming down to feasible levels by the end of 1984. But costs may not be the only problem the U.S. faces; there is often a resistance to changing the process of developing software. Some may be reluctant to accept the risks of new technology. It would be ironic if U.S. computer professionals and their managers were called upon to introduce critical change (e.g., the automation of a previously manual process), yet resisted change themselves when it affected their own modus operandi. Some observers think the Japanese have an edge over the U.S. because of their willingness to try new technologies.

While Japan lags in many of the software product areas, and may be ahead in a few, such as robotics and numerically controlled machinery, it is clear that they are most seriously pursuing process technology in a quest for a larger share of global markets. What might explain Japan's strategy and the relative importance of process technology? William Davidson attempts to supply answers in his book, The Amazing

Race. In analyzing Japan's strategy regarding its economic competition with the U.S., he writes:

> The story that Japanese firms cannot innovate is a myth. Their principal strategy involves entering industries in relatively mature segments, and focusing initially on process technology and value engineering, rather than product innovation. But, as the Japanese strategy evolves in a particular industry, firms typically migrate into the premium product segments of the market in which product innovation becomes increasingly important.[37]

Software's fast-paced changes. Software is a very dynamic technology. One must continually expect and anticipate changes. For example, the Japanese have capitalized on the synergistic effect of their advances in both product and process technology in the development of industrial process control systems. According to Boehm, this is an area where the Japanese are doing better than the U.S.[38] He has noted that software is an area where product and process technology interact more than in other areas. This suggests that future software leadership will be attained by those who succeed in integrating other software product and process technologies.

But the development of software technology alone will not ensure success in developing computer systems. One must also anticipate the effects of new hardware technology. While some feel that the Japanese have pushed the existing hardware technology to its limits in producing their latest supercomputers, it should not be forgotten that the final chapter on supercomputer competition is far from over. To achieve the requirements for supercomputing in the 1990s and beyond, many are counting on computer hardware that will employ massively parallel computer hardware architectures. This in turn will encourage new languages, programming techniques, and software.[39] It is critical to understand the exigencies of this technological development and how they

are likely to change, especially with regard to the transfer of technology.

APPENDIX NOTES

1. Interview with David Talbot, Director, Software Engineering, Alvey Directorate, the U.K., June 13, 1984.

2. Interview with Winston Royce, Director, Data Systems Engineering, Lockheed, June 28, 1984.

3. Interview with Gordon Raisbeck, Consultant, Lexington, Ma., April 20, 1984.

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25. Interview with George Lindamood, Burroughs Co. Ltd., Japan, May 7, 1984.

26. Interview with Ralph Walker, Chief, Tactical Systems Group, National Security Agency, Research and Engineering, May 3, 1984.

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