JAPAN'S MINISTRY OF INTERNATIONAL TRADE AND INDUSTRY (MITI) AS A POLICY INSTRUMENT IN THE DEVELOPMENT OF INFORMATION TECHNOLOGY

Justin L. Bloom

Program on Information Resources Policy

Harvard University

Center for Information Policy Research

Cambridge, Massachusetts

A publication of the Program on Information Resources Policy.

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October 1984, P-84-6

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The Program on Information Resources Policy is jointly sponsored by Harvard University and the Center for Information Policy Research.

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Printing 5 4 3 2 1

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The Washington Post Co.
Western Union
Wolters Samsom Group (Holland)

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ACKNOWLEDGMENTS

This study has attempted to evaluate both the psychological and the physical nature of the MITI R & D function and therefore has relied on personal interviews with knowledgable Japanese officials as much as on the available literature. While these officials have asked that they not be quoted, their cordiality and willingness to express their views requires that their cooperation be acknowledged by name. They are: Kiichiro Abe, Division Director, Agency of Industrial Science and Technology, MITI; Dr. Kaoru Ando, Special Assistant to the President, Fujitsu Limited; Yoichi Anzai, Assistant Director, Science and Technology Department, Keidanren; Dr. Seiichi Ishizaka, Advisor, Nomura Research Institute; Fumihiko Kamijo, Director, Development and Promotion Department, Information Technology Promotion Agency; Masa Kamimura, General Manager, Washington Office, Overseas Electrical Industry Institute (former MITI official); Fumihiko Kato, graduate student, Stanford University (on leave from Information Processing Division, Machinery and Information Industries Bureau, MITI); Ayako Kuwahara, Staff Specialist, International Research and Development Cooperation Division, Agency of Industrial Science and Technology, MITI; Soichi Nagamatsu, Assistant Director, Electronics Policy Division, Machinery and Information Industries Bureau, MITI; Shojiro Otani, Director, Department of General Affairs, Information Technology Promotion Agency; Bunro Shiozawa, graduate student, Stanford University (on leave from Planning Division, Minister's Secretariat, MITI); Nobuo Tanaka, First Secretary, Economic Section, Embassy of Japan, Washington; Dr. Michiyuki Uenohara, Executive Vice President and Director, Research, NEC Corporation; Tadashi Uozumi, Assistant to General Manager, Technology

Administration Division, Fujitsu Limited; Yuji Yamadori, Manager, Planning, Administration Department, Japan Information Processing Development Center; Akinobu Yasumoto, Director, International Research and Development Cooperation Division, Agency of Industrial Science and Technology, MITI; Tadashi Yoshioka, Executive Director, Japan Electronic Industry Development Association.

Valuable guidance and assistance were received from the staff of the American Embassy in Tokyo, including Gerard F. Helfrich, Counselor for Scientific and Technological Affairs; Shinsuke Asano, Scientific Affairs Specialist; and Jack Osborn, Attache for High Technology, Economic Section. George E. Lindamood, then in the Office of Naval Research, Tokyo, provided important personal views and background information. The Office of Japanese Affairs of the Bureau of East Asian and Pacific Affairs, and Pamela Smith, desk officer for Japan, Bureau of Oceans and International Environmental and Scientific Affairs, Department of State, facilitated access to the American Embassy in Tokyo and furnished useful literature references.

Prof. Daniel I. Okimoto of Stanford University's Northeast Asia-United States Forum on International Policy and his associate, Henry K. Hayase, gave freely of their time and expert knowledge of Japanese industrial and technological policies.

Hilary M. Uyehara of Arlington, Virginia, translated the appendix on the PIPS program and Dr. Joshua Silverman of the University of Maryland assisted with domestic literature searches.

The advice, encouragement, and support of Prof. Ezra F. Vogel, Program on U.S.-Japan Relations, Harvard University, is gratefully acknowledged.

Special thanks are due to the following persons who reviewed and commented critically on drafts of this report:

Lauren Ackerman
Noburo Akima
John A. Alic
Harvey Brooks
Linda A. Culhane
Neil W. Davis
William F. Finan
Patricia Haigh
Martha Caldwell Harris
Richard W. Heimlich
Jan Herring
Seisuke Komatsuzaki
David McManis
D. V. Morland
George Needham
Lionel H. Olmer
Richard W. Petree
L. John Rankine
Robert B. Reich
Richard J. Samuels
William Shader
Lawrence F. Snowden

These reviewers and the Program's affiliates are not, however, responsible for or necessarily in agreement with the views expressed herein, nor should they be blamed for any errors of fact or interpretation.

Executive Summary

Contrary to the popular view of MITI as the autocratic manager and financier of all sectors of the Japanese industrial economy, MITI has been a relatively small participant in influencing the course of development of information technology through direct financial support of R & D in this field. In general, funding for industrial R & D in Japan comes far more from the private sector than from MITI or other agencies of the Government. MITI's broader economic policies have affected the course of Japanese success in computers and communications and for this reason alone the importance of MITI cannot be denigrated.

From MITI's point of view, it has assumed a major part of the responsibility for carrying out the development of future information technology, although it has not established itself as the primary factor in this endeavor. It is, in fact, considered more or less an interloper by some in Japan. The Ministry of Posts and Telecommunications and the government-controlled Nippon Telegraph and Telephone Public Corporation remain dominant public organizations in the communications field. Other Government ministries and agencies make technical contributions as well. Private industry in Japan appears capable of conducting its own R & D on information technology without either guidance from MITI or its financial support, but MITI tries to focus the direction of this research to avoid unnecessary duplication and to meet perceived national needs.

MITI by itself is not responsible for Japan's economic success. Rather, its forte appears to be its ability to bring divergent points of view together in creating national policies that are generally acceptable to the various sectors of the society. Consensus-building

remains one of the striking features of the Japanese scene. Japan's and MITI's successes in the post-war era have been due in large part to the political stability that has been enjoyed. This stability has enabled MITI to perform its role of guidance and coordination in an effective manner.

By U.S. standards, MITI is a small government organization, in terms of both budget and personnel. Its closest analogue in the U.S. is the Department of Commerce, but the analogy is not close. For example, MITI has heavy energy responsibilities and Commerce does not. MITI is about one-third the size of Commerce and somewhat smaller than the Department of Energy. About 30 percent of MITI's employees are located in its Agency of Industrial Science and Technology and subordinate research institutes. This agency has a budget of about $500 million per year, of which only a small fraction is spent on the development of information technology. However, MITI's interest in information technology is reflected in the large number of other bureaus, sections and offices which have responsibility for one facet or another of the development and application of information technology. They collect statistical data on industrial products; plan comprehensive policies for the electronics and allied industries; promote the use of computers and cultivate the development of software and data processing services; control the export and import of electronic machinery, including communications equipment; make R & D loans and grants to industry; maintain a National R & D Program; set national industrial standards; and control issuance of patents. In addition, MITI sponsors large-scale National Projects combining the R & D capabilities of

several industrial organizations and government laboratories. A number of these projects have been in the field of information technology and have attracted international attention. However, only about 10 percent of MITI's industrial technology effort is concerned with the information sector.

The effectiveness of MITI is not measured by its budget or its size but by the web of communications and coordination that MITI has established with the private sector. Two industrial advisory councils form direct links. One of them prepares the MITI "visions" which set the long-term course of industrial development in Japan and the other evaluates the state of industrial technology, including information technology. Hundreds of industry-specific trade associations exist under MITI auspices, and of these, many are connected with information technology. On occasion research associations are formed by MITI to conduct large-scale government/industry projects. The entire network is the most unusual facet of MITI's interaction with industry.

With the advent of an era marked by Japan's broad economic success and by inroads made in world markets by the Japanese information industry in particular, MITI's role in sponsoring R & D on information technology through both fiscal and administrative measures may change either toward support of research which is more fundamental in character or toward a much lower level of involvement. Hard decisions in this regard have not yet been made.

The MITI structure for the development of industrial technology cannot necessarily be duplicated in the United States, but there is no reason why useful elements of this structure should not be used in the U.S. to improve industrial performance.

Setting the Scene

This study examines one facet of the emergence of Japan as a world-class innovator and developer of information technology: the part that has been and is being played in this endeavor by the Japanese Government's Ministry of International Trade and Industry (MITI). It must be emphasized that the scope of the study is therefore quite restricted and is not intended to be either a general discourse on MITI's overall involvement in Japanese industrial policy or a broad treatment of information technology development in Japan. However, whenever possible, the interfaces with these larger subjects are defined.

This study has coincided with a widely debated issue: should the U.S. adopt a national industrial policy to revitalize its declining industries and to accelerate the introduction of new technologies? By implication if not outright assertion, the model for American thinking is Japan, a nation that is viewed by some in the U.S. as the epitome of an organized but democratic society in which the interests of government and industry are fully integrated and in which the government directs or guides industry into paths deemed to be the best for future economic success. In this concept, a powerful central governmental authority is seen as requisite, and for Japan this entity is widely accepted as being MITI.

However many who have studied the development of information technologies in Japan have ascribed Japan's success in this field to the entrepreneurship of private industry, the technical leadership of Nippon Telegraph and Telephone Public Corporation (NTT), or to a combination of both factors. MITI is looked on by this group as a latecomer in

information technology, a competitor of the Ministry of Posts and Telecommunications (MPT), and as probably not as important to Japan's success in this field as it has been in others. In the field of information technology, MITI's actions may have been following market trends rather than creating them.

In the United States, the Congress is considering legislation for creating a Department of International Trade and Industry (DITI), and the similarity to the MITI acronym is hardly coincidental. Yet it is commonly recognized that if the United States proceeds along this path, its DITI cannot be an exact analogue of MITI. MITI is part of a parliamentary form of government and hence not subject to the checks and balances of the American executive/legislative/judiciary structure. Perhaps more important, there are major societal differences between the U.S. and Japan. Each nation has evolved from its own set of geographic, ethnic, cultural, and economic constraints. Because of the deep "faith" of certain groups in the U.S. in MITI, this study has been conducted to clarify MITI's role, to see whether this organization indeed offers useful lessons.

Related Studies

A number of other investigators have studied or are in the process of evaluating the broader issue of Japanese industrial policy and its implications for the United States (1-6). They consider MITI to be the focal point or the guiding force in this respect, but they do not concentrate or dwell exclusively on the strength of MITI as a sponsor, organizer, and participant in research and development. Others (7-11) have paid considerable attention to the effects of the Japanese Government's sponsorship of research and development on information

technology, including the MITI influence. Of these, three are particularly germane to this study. One is the recent report (7) of the International Trade Commission to the Congress on foreign industrial targeting, which, while covering other segments of Japanese industry, goes into some depth on the Japanese Government's science and technology policies and their pertinence to information technology development. Another is the exhaustive treatment of the Japanese semiconductor industry that was published recently by Professor Daniel Okimoto and colleagues at Stanford University (8). It is not limited to MITI interests and does not treat the field of information technology as an explicit subject. The last is a comprehensive study of international competitiveness in electronics performed by the Office of Technology Assessment of the U.S. Congress (9). It covers countries other than Japan and also is not concerned exclusively with information technology or MITI interests.

This study will attempt to provide further detail and analysis insofar as MITI is concerned.

The Information Society

Several large and advanced nations of the world -- the United States, Japan, the United Kingdom, France, and the Federal Republic of Germany among them -- appear to be moving toward what some call the post-industrial society and others call the information society. This is a milieu in which service industries begin to predominate as automation reduces the labor component of manufacturing, agriculture, transportation, and even commerce. The manpower so freed is expected to become ever more heavily involved in the dissemination and use of information or knowledge.

In Japan, this movement is strongly encouraged and even orchestrated to some extent by the Government (12-16). This movement has a heavy technological content. This is consistent with a plan which fits the seemingly insatiable appetite of the Japanese people for information to the increasing availability of sophisticated systems for collecting, storing, and disseminating knowledge.

MITI As An Organization

MITI is probably more heavily engaged in domestic industrial planning, development, and regulation than it is in the international aspects of these activities. MITI can legitimately look upon the evolution of the information society in Japan as a creator of markets for industrial products, a stimulus to industry, and hence a justification for the conduct of government-sponsored R & D. It is this process of tracing a national goal back to industry that permits MITI to become involved even when other parts of the Japanese government's hierarchy appear to have dominant policy or operational rights.

The Historical Development of MITI's Technical Functions

Chalmers Johnson, an authority on Japan, at the University of California, Berkeley, has described the political and administrative history of MITI in considerable depth, with emphasis on trade and economic factors (3). However, he has not covered a large part of MITI's responsibilities; specifically, its functions as a large technical agency in the conduct of research and development, and in the sponsorship of R & D by industrial organizations. While MITI's technical role cannot be divorced from its other responsibilities, it will receive special attention in this study.

The Meiji Restoration of 1868 marked more than the reopening of Japan to the West. It was the turning point for the conversion of a feudal agrarian society into a modern industrialized society -- an imperative for a nation with a growing population, limited arable land, and a great scarcity of mineral resources. Toshio Shishido, vice president of the International University of Japan, recently identified the early stages of the government's involvement in industrial

development in Japan and the evolution of national science and technology policies as a consequence (17).

-- In 1870 a Ministry of Engineering was created in the Imperial Government to encourage the development of new industries and to run the country's mines, railways, and communications.

-- To develop an effective industrial policy, the Government brought in academicians and businessmen to act in advisory capacities through the medium of research councils or boards. Among these was the Production Research Council, formed in 1910.

-- The Research Council of the Chemical Industry recommended that the Government give priority to research and the physical and chemical sciences, and a laboratory for this purpose was established in 1917. It is still in existence as the Institute of Physical and Chemical Research (Rikagaku Kenkyusho, or "Riken").

-- In 1920, research institutes associated with Imperial (now national) universities were initiated at Tokyo (for aviation) and at Tohoku (for metals). By 1968, about 200 such institutes existed, and the institutes at Tokyo and Tohoku Universities are still in operation.

-- Growth and integration of government research institutes in Japan continued into the post-war era. In 1948 an Agency of Industrial Science and Technology (AIST, or Kogyo Gijutsu In) was formed from 12 previously established institutes and was attached to the Ministry of Commerce and Industry*. This Ministry was restructured in 1952 and its name was changed to the Ministry of International Trade and Industry (MITI). In 1962, AIST assumed the responsibility for MITI's administrative activities in industrial science and technology. The

* During the war years of 1943 to 1945, the Ministry of Commerce and Industry was renamed the Ministry of Munitions.

laboratories under MITI's purview became semi-independent entities under AIST guidance and financial control. These now number 16, nine of which are in new research facilities in Tsukuba Science City north of Tokyo (18,19). Because of its importance in carrying out the development of information technology, more will be said later about AIST and certain of its laboratories.

Size and Personnel Relationships

By American standards, MITI is not a large government agency. According to the Ministry's own data for the Japanese fiscal year 1978, it had 13,890 employees, of which 2,285 were in the internal central bureaus, 4,727 in attached agencies, 3,862 in regional branches, 2,342 in the Patent Office, and the remainder in two small agencies (20). The number of employees has not changed to any significant degree in the intervening years. Thus only about one-sixth of MITI's employees are engaged in central policy-making and administrative activities. Of these, very few are specialists who remain in a particular position for long periods of time. The general policy of the Japanese Government is to move people around for the purpose of broadening their experience (especially those identified as future leaders), and this is also seen in MITI. It is difficult for a non-Japanese to understand how complex technical programs can be initiated, managed, and evaluated without a cadre of in-house technical experts. The answer seems to lie in the continuous, multi-layered consultative process that leads to the development of a consensus. Specialists are brought in for advice as needed, and they may come from any segment of the Japanese society.

A characteristic of the approach of management in MITI (and in other Japanese Government agencies) is that individual personalities

rarely emerge. Ministers (who are members of the Cabinet as well as members of the Diet) and the two Parliamentary Vice Ministers (also Diet members) rarely remain in their positions for more than two years. At times of political upheaval they may be changed at more frequent intervals. The key senior official for operational purposes is the career Vice Minister, who on occasion has achieved an atypical degree of renown (21). Bureaucrats at lower levels are moved from job to job with little apparent continuity of function but at almost predictable intervals.

Very few MITI officials outside of the Agency of Industrial Science and Technology (AIST) have professional engineering or scientific backgrounds. Even in AIST headquarters, some non-technical people are found in the middle- and upper-level management positions. The highest level technical/managerial position in MITI is that of the Director General of AIST. He is a long-term MITI employee who usually has spent a large proportion of his career at one of the MITI laboratories. Depending on his personality and drive, he may be a member of the MITI inner circle of policy makers or he may be kept on the outside as a "technician." His position is a terminal one: he will not be promoted to the somewhat higher level of vice minister (the highest position occupied by a civil servant in the parliamentary system), and he probably will retire from the Civil Service at the end of his term to take a position in private industry. There is little movement back and forth between government and industry or government and academia of Japanese Civil Service employees, except that it is traditional for some civil servants to enter industrial or academic employment upon their retirement.

At the laboratory level, the situation is quite different. There, specialists play much the same role as they do in government laboratories in the United States. Only a few will move to Tokyo to take up AIST management positions. The lack of personnel mobility for scientists and engineers among the various government and industry sectors still persists.

The Bureau Structure

As far as internal organization is concerned, MITI has no unusual structure. It consists of a series of bureaus headed by Directors General who report to the Vice Minister. Each bureau is composed of a number of divisions and within each division there are several offices. In accordance with the general Japanese philosophy of "bottom up" management -- decisions tend to be made at an intermediate supervisory level and work their way to higher management levels for endorsement -- the section chiefs or division directors are the key officials in terms of knowledge and influence(22). They typically supervise about 20 to 30 people, although there is no rule to this effect.

What is unusual about MITI's structure is the web of industry advisory bodies and associations attached to it. How these entities affect the development of information technology will be looked at following a discussion of MITI bureaus and divisions concerned with information technology.

The Machinery and Information Industries Bureau -- A Focal Point for Policy on Information Technology

The key MITI bureau involved with information technology is the Machinery and Information Industries Bureau. The official charter of this bureau states: (23)

> "[The Bureau] is in charge of administering affairs for promoting, improving and coordinating the export, import, production, distribution and consumption of machinery and mechanical apparatus."

This broad mission is narrowed by putting aside the Bureau's responsibilities for the automobile, aircraft, machine tool, and other industries which are outside this study, and only the divisions and offices which are directly involved with information technology are shown. The number of divisions and offices involved with information technology is an indicator of the importance that MITI attaches to this subject.

The General Affairs Division

The General Affairs Division of the Machinery and Information Industries Bureau provides overall coordination of the Bureau, collects statistical data on the industrial products under the Bureau's purview, and performs other housekeeping functions concerning administration of laws, taxes and fiscal matters, and consumer protection. This division is also responsible for the: (24)

> "....overall coordination of affairs concerning technology, research and development, and prevention of industrial pollution...."

for the lines of business under the control of the Bureau. It thus plays a part in the management and direction of R & D on information technology. Within the Division, a Social Systems Development Office promotes surveys and R & D on systems generally related to societal

needs, and is specifically responsible for integrating the computer into other mechanical systems such as a health-care network system and a visual information system. The relatively small Space Industry Office of the Division plans and administers programs connected with industrial manufacture of space-related equipment. This is important as MITI emerges as a participant in satellite-based information collection and dissemination systems.

The Electronics Policy Division

The Electronics Policy Division of the Bureau is one of the most important organizational units of MITI involved with information technology. This division plans comprehensive policies for the electronics equipment industry, is involved in the distribution of computers and plans programs for their use, and is the point of contact for the external Data Processing Promotion Council. It represents the Japanese Government on matters concerning computers and other information systems in several international organizations such as the Committee on Science and Technology Policy of the Organization for Economic Cooperation and Development (OECD) (25).

The Data-Processing Promotion Division

The Data-Processing Promotion Division of the Machinery and Information Industries Bureau was established to administer a special 1970 law creating the Information Technology Promotion Agency (IPA). IPA is not staffed by government employees like AIST, but does receive much of its funding from MITI. The Data-Processing Promotion Division and IPA work together in three broad areas: to promote the use of computers and the development of business-oriented software; to cultivate the data-processing service business; and to license data-

processing technicians according to national standards of competency. The Division also maintains international contacts with organizations like the Economic Commission for Europe (ECE) and OECD (26). The operations of IPA will be further discussed later in this paper.

The Industrial Electronics Division

The export and import of electronic machinery, its production and distribution, and its industrial development are the responsibilities of the Industrial Electronics Division of the Machinery and Information Industries Bureau. Those responsibilities which fall under the aegis of the Electronics Policy Division -- especially the distribution and utilization of computers -- as well as consumer electronics are excluded. Of particular interest is the Division's responsibility for essentially all communications equipment, such as telephones, facsimile transceivers, switchboards, broadcasting equipment, and all of the components which make up these and other related devices (27). On the face of it, this MITI responsibility appears to be in conflict with that of the Ministry of Posts and Telecommunications (MPT), and with the public and controlled private corporations which provide essentially all communications services to the Japanese public. But again, MITI can justify its involvement by relating it to the promotion of the industrial sector. MPT and the rest of the Japanese Government are either satisfied with this dichotomous structure or have learned to live with it in recognition of MITI's broad involvement with industrial policy and management at the governmental level, but an undercurrent of conflict among individual officials of the various ministries appears to remain.

The Electrical Machinery and Consumer Electronics Division

Consumer electrical and electronics equipment, electrical generators and a host of other related items fall under the Electrical Machinery and Consumer Electronics Division of the Machinery and Information Industries Bureau.

The Agency of Industrial Science and Technology (AIST): The Technical Brains of MITI

Although the Agency of Industrial Science and Technology is not always considered to be part of the MITI mainstream of policy and management,* its size and budget make it important. Only 320 people work in AIST Headquarters (integral with the rest of MITI), but AIST employs 972 administrative personnel and 2,637 engineers and scientists at its 16 research institutes (28). Thus about 30 percent of the total MITI staff is located in AIST and its subordinate facilities.

While the size of AIST and its labs is impressive in Japanese terms, by American standards it is not so. For example, one U.S. national laboratory, the Lawrence Livermore National Laboratory, has more than twice as many employees as all of the MITI institutes combined and a budget roughly the size of the entire AIST budget of about $500 million per year.

Officially, AIST is: (29)

> "....responsible for the planning, dissemination and implementation of comprehensive policies related to MITI's administration of technology, and also the implementation of various experimental and research programs in response to social and administrative needs."

If budget allocations are an indication, the development of information technology per se is not AIST's first priority. Some 43 percent of AIST's annual budget of about $511 million is now committed to R & D on new energy sources and energy conservation through external contracts with industry. About 30 percent, or $153 million, goes to the AIST laboratories, with a fraction of this being spent on information technology development. The remainder is spent on international cooperation, R & D loans to industry, external R & D on basic technology

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* Johnson's study is a good example of the almost universal failure to consider MITI's R & D responsibilities when examining Japanese industrial policy.

for "future industries", and the so-called National R & D Program. The latter, better known as the "Large-Scale Project" or "Big Project" effort, is the category that attracts the most attention abroad when Japanese industrial "targeting" practices are analyzed (30). The National R & D Program has special relevance to R & D on information technology. In the Japanese fiscal year ending March 31, 1984, $68 million was spent on eight current big projects, of which up to five -- depending on the definition -- can be characterized as being concerned with information technology. These will be discussed later in this paper.

The Organization of AIST

Organizationally, AIST is divided into two departments, the General Coordination Department and the Standards Department (31). The latter, with its associated institute, the National Research Laboratory of Metrology, corresponds in partial function with the U.S. National Bureau of Standards but is much smaller. The Standards Department is the remnant of MITI's original technical assignment to set national industrial standards.

In the General Coordination Department there are eight divisions and a large number of independent offices for carrying out special AIST missions. The structure is too complicated (particularly considering the relatively small number of people employed) to be described in depth. The roles of various divisions and offices will be highlighted as they relate to policies for the development of information technology as necessary in subsequent descriptions.

Councils, Industry Associations and Research Associations

Perhaps the most distinctive characteristic of governmental policy formulation in Japan is the elaborate network of advisory bodies which is consulted in every field of government endeavor. Information technology is no exception. MITI has strong motivations to insure that its communications with industry are close and constructive. Differences in views between MITI and the industries it promotes and regulates can be strong enough to be irreconcilable. But every effort will be made to resolve them and to establish the required Japanese consensus. Opportunities for controversy may be particularly strong where the development of information technology is concerned, because here MITI is more or less the infringer. Nippon Telegraph and Telephone Public Corporation (NTT), a government-owned entity, is charged with the sole responsibility for domestic telecommunications in Japan other than radio and television broadcasting.* Its laboratories are considered to be second only to the former Bell Laboratories** in the U.S., although it is generally believed in the U.S. that the NTT laboratories do not engage as much in fundamental research as do the Bell Laboratories. NTT has a network of industrial suppliers who cooperate with it in R & D activities. These companies are also members of the MITI "family," so divided loyalties can exist.

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* Broadcasting is conducted both by a government-owned organization, the Japan Broadcasting Corporation, Nippon Hoso Kyokai (NHK) and a number of private companies regulated by the Ministry of Posts and Telecommunications (MPT).

** Now known as AT&T Bell Laboratories.

In some ways, NTT and its overseeing ministry are more influential than MITI. NTT is a purchaser of enormous volumes of electronic equipment, while MITI is not. NTT's annual budget for communications R & D is currently $390 million (32), or roughly three-quarters of AIST's total budget, and several times more than MITI's annual expenditures on R & D related to information technology. Despite earlier antagonism between MPT and NTT on the one hand and MITI on the other concerning jurisdiction over information technology and its development, a modus vivendi seems to have been reached. Perhaps this is because the same large companies which owe allegiance to MITI are also suppliers to NTT and can propose the necessary accommodations through their advisory functions.

The Industrial Structure Council

MITI has two permanent advisory councils which are important in setting policies on information technology. One is the Industrial Structure Council. It is here that the much-touted MITI "Visions" of the country's economic future originate. This Council recommends the requisite industrial policies needed to meet the projected economic and social needs. The Visions are revised annually to reflect changing domestic and international conditions. One of the standing committees of the Council is concerned exclusively with the information industry (33).

As is the case with most bureaucracies, the Council and its committees rely heavily on the MITI staff for the preparation of the documents which they must ultimately agree on and endorse. The staff, in turn, consults with lower level representatives of industry, academia, and other Government ministries to insure that documents

submitted to the Council are reasonably certain to meet with approval. The Industrial Structure Division of MITI's Economic Policy Bureau performs this coordination role for the Council.

The Industrial Technology Council

The other pertinent council for MITI is the Industrial Technology Council. Originally it was a committee reporting to AIST, but befitting the importance attached to technology by MITI and the Japanese Government, it has now been elevated in stature, and reports to the MITI Minister. The official MITI Handbook (20) gives an explicit definition of the Council's role: (34)

> "In specific terms, the Council studies such matters as identification of tasks for research and development and the roles to be assumed by the public and private sectors in Japan's conduct of its research and development activities, the ideal form which Japan's regional research institutes should follow, the system and methods of implementation for Japan to perform its technology assessment, the methods for Japan to carry out international cooperation in research, as well as many other similar matters. Furthermore, this council is responsible for deliberating on the management of Japan's system of large-scale research and development projects and on Japan's development of technologies for new forms of energy and for energy conservation."

The General Affairs Division of AIST provides the staff support for the Industrial Technology Council. Eight committees, all of them technically oriented, study the themes outlined in the statement quoted above.

The Data Processing Promotion Council

A more narrowly focused MITI council which operates in the information technology field is the Data Processing Promotion Council (35). This Council must review any plan contemplated by the MITI Minister which would raise the utilization of computers in Japan to a higher level of sophistication. This is interpreted to apply to

computers in general use and not to scientific computers. The Data Processing Promotion Council receives staff and financial support from the Electronics Policy Division of MITI's Machinery and Information Industries Bureau.

Industry Associations

Industry associations abound in Japan, even more so than in the United States. They tend to be like their American counterparts in lobbying activities, but are much more integrated into government policy formation and often receive financial support for some of their work from the Government ministries with which they are registered. The associations appear to place less emphasis on lobbying activities aimed at the legislative body, the Diet, than toward Japanese Government ministries and agencies. Dozens of industry associations are connected to MITI (36). Those easily identifiable as belonging to the information technology sector are:

(Under the Machinery and Information Industries Bureau)

-- Electronic Industries Association of Japan (EIAJ)

-- Information Technology Promotion Agency, Japan (IPA)

-- Japan Data Communications Association

-- Japan Electronic Industry Development Association (JEIDA)

-- Japan Information Processing Development Center (JIPDEC)

-- Japan Software Industry Association

-- Kansai Institute of Information Systems

-- The Medical Information System Development Center

-- Optoelectric Industry and Technology Development Association

-- Radioengineering and Electronics Association

-- Society of Japanese Aerospace Companies

-- The Telecommunications Association

(Under AIST)

-- Japan Industrial Technology Association (JITA)

-- Japan Technology Promotion Association

One of these associations, IPA, was created by statute and is directly financed by MITI. The others are officially recognized as being MITI sponsored. The associations are often staffed in part by retired MITI employees or by personnel loaned from member companies. Since the number of companies in any given industrial sector is finite, it is entirely possible that a large electronics company will belong to all of the associations listed. The associations have no fixed lifetime and survive as long as they have the support of their members and of MITI. Three key industry associations involved with MITI in the development of information technology are the Japan Information Processing Development Center (JIPDEC), the Information Technology Promotion Agency (IPA), and the Japan Electronic Industry Development Association (JEIDA).

Japan Information Processing Development Center (JIPDEC)

JIPDEC is the best known of the three to foreign technologists and businessmen because of its long-standing policy of publishing English-language documents on the status of the Japanese computer industry. The authoritative JIPDEC Report, published quarterly, and the annual Computer White Paper are necessary reading for those who follow the Japanese computer industry. JIPDEC performs surveys and research studies and offers consulting, educational, public relations, and international exchange services to both government and industry. It is considered a private organization by Japanese standards, although it has close ties to MITI's Machinery and Information Industries Bureau. It

was involved in the initial planning for the Fifth Generation Computer Development Program prior to that program's designation as an official national project. JIPDEC was established in 1967 as a non-profit corporation. It receives financial support from both MITI and the Ministry of Posts and Telecommunications.

Information Technology Promotion Agency (IPA)

IPA was formed in 1970, through the passage of a special law, and is the only organization to promote the development and sale of software under government auspices. Half of its funding comes from the Government. Partial investment from the public is said to be encouraged due to a desire for cooperation and involvement from the private sector. Its responsibilities are:

1. To assign by contract the development of advanced and general purpose computer programs within the constraints set by the annual budget.

2. To purchase advanced and general purpose computer programs for resale to the public.

3. To market computer programs developed under IPA contracts.

4. To conduct studies and surveys related to computer software utilization and to distribute the results.

5. To promote advanced information processing technology.

6. To act as guarantor for moneys borrowed by information processing companies from private banks.

IPA considers its assistance to small, independent software developers and users as one of its most important functions. (The large, vertically integrated computer manufacturers ordinarily do their own software development.) This business activity is relatively slow at

present because independent software development has not yet reached the level of maturity in Japan that it has in the U.S., according to IPA. "Maturity" here is assumed to mean independence from foreign suppliers*. However, some American experts believe that Japan is not lagging that far behind in the development of computer software and should not be underrated.

IPA does not get involved with communications software, since that falls under NTT's responsibility. It does no software development itself, since it has a staff of only 50 people and no laboratory facilities.

Japan Electronics Industry Development Association (JEIDA) and Related Organizations

JEIDA is deeply involved in the entire development process, from early planning through execution. The executive director of JEIDA chairs the Information Industry Subcommittee of MITI's Industrial Structure Council and through this channel proposes new research themes to MITI. Working groups of the Subcommittee meet frequently, perhaps once a month, while the Subcommittee meets three or four times a year. The "bottom up" process for creating new themes is used. Recent subjects of interest include "new media" (teletext, videotex, cable TV,

* Of particular interest in this respect is an increasing number of joint ventures with U.S. companies for developing and selling software in Japan. One of these, formed by the Nihon Keizai Shimbun (Japan Economic Journal) and McGraw-Hill, is focusing on software for the rapidly expanding personal computer market. Another, with Microsoft Corporation, is developing a standard operating system (known as MSX) for personal computers manufactured by at least 10 Japanese corporations which will be similar to (and probably compatible with) the MS-DOS and PC-DOS systems widely used in the U.S. -- especially in the IBM Personal Computer (37, 38).

direct broadcast TV, etc.), software protection, and software security. Representatives of JEIDA directly support MITI officials in making budget representations for information technology projects to the Ministry of Finance.

JEIDA does not cooperate closely with IPA, although member companies contribute financial support to both organizations. IPA is viewed by JEIDA as being primarily a financing organization for software development, while JEIDA is concerned mainly with hardware. The exception is operating system software developed by computer manufacturers, for which JEIDA has some responsibility.

Since JEIDA has 170 corporate and association members, it is too large to be effective as a research association and does not meet the other usual criterion of being prepared to expire on completion of a project. It receives essentially no financial support from the central government, although reportedly MITI/AIST furnishes a small amount of funds for standards development. Fifty percent of its annual budget of 1.5 billion yen ($6.5 million) for projects comes from the proceeds of the Japan Bicycle Racing Association (that is, profits from betting on bicycle racing) and the remainder comes from private industry. JEIDA's internal costs are much smaller, and the Bicycle Racing Association provides only 6 percent of them.

Another organization which until 1983 was part of JEIDA and still is closely tied to it through interlocking directorates is known as Center of the International Cooperation for Computerization (CICC). This organization is being funded through a MITI grant of 110 million yen and has a total budget of 900 million yen, part of which comes from bicycle racing revenues. Its function is to establish links with

foreign countries and international organizations such as the United Nations Industrial Development Organization (UNIDO), the Economic and Social Commission for Asia and the Pacific (ESCAP), and United Nations Headquarters.

JEIDA also maintains close ties with the Electronic Industries Association of Japan (EIAJ), a much larger organization of 500 company members. EIAJ is primarily concerned with consumer electronics and has many small companies as members. JEIDA enrolls only large companies as members and limits its interests to the industrial sector (39).

Nippon Telegraph and Telephone Public Corporation (NTT) has no formal relationship with JEIDA, although individual experts from NTT act as advisors.

Research Associations

Research Associations in Japan are often confused with the industry associations. However, the research associations are created by MITI initiative to coordinate industrial participation in a specific MITI Large-Scale Project. In a few instances they have actually managed R & D activities. A notable example of this was the VLSI Research Association which was formed in 1976 to carry out what was at the time MITI's largest project in the information technology field -- the development of manufacturing technology for very large scale integrated circuits. Members of the VLSI Research Association established a joint research laboratory (using the facilities of one of the companies), staffed it, and carried out important R & D until the expiration of the project in 1980.

Research associations are kept in existence only through the lifetime of the project with which they are associated. Their operation

costs are shared by MITI and the member companies according to a negotiated formula. This varies from case to case but seems to approach a standard of equal sharing. Research associations are staffed by a mixture of Government employees on detail, private company employees on detail, and by retired officials hired for the purpose.

Interactions of MITI with Other Government Ministries and Agencies

The Economic Planning Agency (EPA) and the Ministry of Finance (MOF)

There is a prevailing impression among non-Japanese that MITI is an administrative autocracy essentially independent of the rest of the Japanese Government. But MITI must interact continuously with most of the other ministries and agencies of the central Government, since consensus building occurs horizontally as well as vertically. In particular, MITI must maintain good relations with the Economic Planning Agency in the Prime Minister's Office if its plans are to receive endorsement in the annual Economic White Paper. The same is true with the Ministry of Finance, which determines the national budget and MITI's share of it. According to Chalmers Johnson (40), MITI has powerful influence in the Economic Planning Agency, but the Ministry of Finance appears to hold its own. There have been a number of indications that MITI's plans for accelerating the growth of certain technologies have been rebuffed by the Ministry of Finance, probably more for fiscal than for technical reasons. On the other hand, Finance must have agreed to MITI's entry into the information technology field which was already well occupied by the industry and NTT. MITI probably was able to justify expenditure of Government funds for building a common technology base that would support all companies, and the companies themselves were willing to endorse this proposition when queried by Finance.

The Science and Technology Agency

In research and development, MITI must take into account the responsibilities of two other government organizations besides MPT and NTT, when information technology is considered. One of these is the Science and Technology Agency (STA), which is part of the Prime

Minister's Office. Because of its heavy commitments to nuclear energy and space development -- the two largest R & D programs of the Japanese Government -- STA has a larger R & D budget than MITI. Officially, STA is supposed to perform overall government planning for science and technology, but the Japanese Government has never been that well integrated horizontally. Thus there is competition and rivalry between MITI and STA for the limited funds available for R & D, as well as for program responsibilities. This does not appear to have been a major problem in the information technology field for at least three reasons: most of the R & D in this area is conducted by private industry at its own expense; NTT has dominated the field in terms of government-owned facilities; and STA has relatively limited (but high quality) in-house resources, primarily at the Institute of Physical and Chemical Research, Riken.

However, it is something of a mystery why MITI has been able to assume management responsibility for the development of an earth resources observation satellite when all other applications satellite development projects in Japan are sponsored by STA. In response to inquiries about this shift, the only answer given was that MITI "raised its hand" when a management decision was being made, indicating that it had some working funds available and STA did not. This may have implications for MITI's future role in the development of communications satellites.

The Ministry of Education, Culture and Science

The other government organization with heavy technical interests in information technology is the Ministry of Education, Culture, and Science (MOE). This ministry sponsors all academic research in the

national universities and a substantial part of that performed in the private universities. Historically, there appears to have been little, if any, formal cooperation between MITI and MOE in research, although university professors are often used as consultants and as members of advisory bodies.

This situation is changing, since there are mounting pressures at the political level to improve the government/industry/university technical relationship. Evidence of the change can be found in the new organization created to manage what portends to be MITI's largest technical project, the Fifth Generation Computer Project. The Institute for New Generation Computer Technology (ICOT) which has been formed for this purpose has strong technical advisory representation from all three segments. It is headed by a senior scientist from the MITI/AIST Electrotechnical Laboratory at Tsukuba. Edward Feigenbaum of Stanford University has analyzed at some length the MITI/ICOT structure and MITI's involvement in what for the time being is a basic research program and therefore apart from MITI's conventional interests(41). ICOT is not a research organization like that established for the VLSI project, since for the time being, it is completely funded by MITI.

Feigenbaum has outlined MITI's involvement with other Japanese Government ministries in the Fifth Generation Computer Project as follows:

> "Given MITI's own enchantment with the power of knowledge, it is not surprising that [a] few years ago it decided that Japan should move ahead into the information age. In truth, MITI's decision was only part of a nationwide governmental decision to push Japan in that direction, allying MITI with other government ministries such as the Ministry of Health and Welfare, the Economic Planning Agency, and the Ministry of Posts and Telecommunications. Programs are planned by each of these agencies to carry out the national imperative, and, of

course, the Fifth Generation will be central to fulfilling the aims of all."

Federation of Economic Organizations (Keidanren)

Another layer of coordination for industrial R & D is a powerful consortium of associations and corporations, the Federation of Economic Organizations, now known worldwide by its Japanese name, Keidanren. In 1982 it was composed of 110 association members and 812 private companies (42). It has been likened to the National Association of Manufacturers and the Chamber of Commerce in the U.S. (43,44), but at best the likeness is hazy. Keidanren is more powerful and influential than its closest U.S. counterparts. It has a large staff of full-time professional employees, some of whom are in a Science and Technology Department. Standing committees headed by Japan's most prominent industrialists continuously evaluate the future course of Japan's economy from every aspect and advise the Government -- particularly MITI -- of their views. Committees directly related to information technology include one on Data Processing headed by Taiyu Kobayashi, the Chairman of Fujitsu Limited; one on Industrial Technology, headed by Sadakazu Shindo, Chairman of Mitsubishi Electric Corporation; and one on Space Activities, headed by Koji Kobayashi, Chairman of NEC Corporation.

Keidanren enjoys a singular advantage compared to similar organizations in the U.S. The headquarters offices of most of its member companies and associations are in Tokyo, in close proximity to Keidanren itself and to the offices of the Government. Thus, coordination among the various bodies is relatively easy to arrange, particularly in terms of the frequency of personal contacts. However, the most important factor in determining the value of Keidanren's influence is the spirit of perceived mutual benefit that has existed for decades between the Government and industry. The objectives of the

public and private sectors are generally the same, although differences arise in defining approaches and methods.

Keidanren has enough power and stature to react adversely to MITI concepts and plans when it believes that it is necessary to do so; that is, on those occasions when MITI decides to take an action without having reached a consensus with the private sector. On the other hand, MITI is not obligated to accept all of Keidanren's proposals and recommendations, due to budgetary and political constraints.

Some recent examples of Keidanren's interactions with MITI in the field of information technology demonstrate how it influences government policy. To facilitate the development of an indigenous software industry, MITI has asked Keidanren for its advice on establishing a new law covering intellectual property rights to computer software. This is a highly controversial subject which has triggered a new element of U.S.-Japan trade friction. The law has been proposed by the Information Industry Committee of MITI's Industrial Structure Council (45-48). It is opposed by the Ministry of Education, the organization traditionally responsible for copyright policy. Keidanren seems to be going along with the MITI approach, although reluctantly and after much debate. It might have been assumed that Keidanren's position would be in exact conformity with that of the MITI committee -- since the Committee members are mostly representatives of large private companies and hence members of Keidanren. However, banks, trading companies, and other organizations not directly involved in R & D or manufacturing may have different positions. Keidanren, like similar U.S. organizations, must make internal accommodations. It represents all members in responding to MITI requests.

In the spring of 1983 Keidanren sent out questionnaires to the vice presidents of research of 37 firms to obtain their views on the way that the Government supports industrial R & D. Of those responding, 60 percent generally supported the approach being used, but identified the following issues:

-- Industry and Government should share patent rights resulting from government-sponsored R & D, instead of the scheme now employed where the Government retains the rights when it contributes more than 50 percent of the R & D funding.

-- The present system of single-year budgeting and funding of R & D is not suitable and should be replaced by multi-year funding.

-- Procedures for obtaining government financial support for R & D are too complicated.

It need hardly be said that these points would be quite at home in an American context.

In July of 1983, Keidanren's Space Activities Promotion Council (or Committee) made sweeping recommendations (49) on the future of the Japanese space program. This included a controversial one calling for the indigenous development of large (two to four ton) communications satellites rather than procuring them from abroad (i.e. the U.S.). This also has added to the list of trade friction items being debated by the U.S. and Japan. This problem may have been resolved by an announcement by the Japanese Government stating that private companies will be allowed to buy communications satellites from whatever source. (50) It is not clear at this time whether NTT will be defined as a private company for this purpose.

While Keidanren is obviously a lobbying organization for the industrial sector, it is not monolithic and its views and positions are not automatically endorsed by the Government. Likewise, Keidanren is not a pushover for government policies and plans. Typically, Keidanren has taken a position of favoring government measures to stimulate the economy, in opposition to those in the Government who have set the control of inflation as their prime objective. (2)

The Diet

The role of the Diet is quite different from that of the U.S. Congress. In the Japanese parliamentary form of government, the Diet debates national issues at the insistence of the minority political parties and formally approves legislation proposed by the Government. Since the Government (i.e., the Prime Minister and Cabinet) is comprised of members of the Diet from the majority party, there are no formal differences in position between the Government and the majority party in the Diet. This structure is almost identical to that of the British Parliament.

The Diet has the reputation of being largely a rubber stamp for Government proposals, and it rarely initiates legislation itself (51). This does not mean that individual Diet members are impotent. They exert influence on ministries in representing their constituencies and they are appointed as heads of ministries and agencies and as parliamentary vice ministers. They make up the large majority (usually 100 percent) of the Cabinet. A number of Diet members have special interests in science and technology, and in information matters. Standing committees for science and technology exist in each of the two houses of the Diet. Furthermore, the majority party, the Liberal Democratic Party, also maintains a more or less formal interest in the subject, and its individual members can be active in influencing policy. In general, the Diet as an organization is not important in determining research and development goals or in setting detailed policies for an information society, but on occasion it can be a stumbling block for government intentions. The best recent and pertinent example of this occurred in the summer of 1984, when the upper house of the Diet failed

to approve the Nakasone Administration's legislation designed to reform the domestic telecommunications industry (52). The delay is probably temporary and may have been due as much to residual, internacine differences between MITI and the Ministry of Posts and Telecommunications (MPT) as to anything else.

Japanese society seems to be in a continuing state of dynamism (particularly in regard to the growth of a consumer movement). The ultimate impact of a more vocal and demanding electorate may be in a stronger Diet, insofar as national policies are concerned. This could be particularly true for policies connected with the information society, since these will tend to bear directly on the population at large rather than the special interest groups that currently influence the Diet and the ministries to such a great extent.

The Legal Basis for MITI Policies and Programs

MITI receives its authority to operate through a series of laws passed by the Diet after being proposed by the Government. The laws bear little resemblance to those of the U.S. They are often vague and general, befitting a nation that has fewer practicing attorneys than Washington, D.C. Perhaps their most distinguishing feature, in the context of this study, is that they empower Government ministries to engage in "administrative guidance" -- rules of procedure for the public that are not spelled out or written down in the national statutes and hence are not truly enforceable by law. The practice is accepted by the public at large, and by industry in the case of laws pertaining to MITI, as part of the generally non-confrontational relationship that exists between the public and private sectors in Japan. Johnson (3) has dealt with the phenomenon of administrative guidance at considerable length.

Among many laws giving MITI its authority to act in the field of information technology is the "Extraordinary Measures Law for Development of Specific Machinery and Information Industries." (Law No. 84, July 1, 1978). It replaced a similar law enacted in 1971 and is due to expire in 1985. While the term "information technology" itself is not found in Law No. 84, the statute gives the MITI Minister broad powers to develop new electronic equipment, components, and computer software, to insure that proper functional standards for the industry are established, and to control competition to some extent for the purpose of optimizing production and quality.

MITI/Industry Policy Interactions

A primary objective of this study has been to obtain first-hand knowledge of the process by which MITI identifies new policies and programs in the field of information technology and how it interacts with the industry in developing the necessary consensus and then procedural mechanisms. To accomplish this task, interviews were conducted individually with a variety of Japanese government and industry officials located in Washington, Tokyo, and other cities.*

Typically, representatives of industry described their relationship with MITI as being something of the arms-length variety -- not as negative as what some have called a "love-hate" relationship but not as cozy as believed by most Westerners. This relationship has evolved from conditions of an earlier time when the Japanese economy was so weak that the Government was looked to for direction and funding in every aspect, including the supply of technology. The textile and shipbuilding industries are cited as having been formed by this approach, mostly before World War II. The information industry, which might be described as a combination of the electronics and communications industries, is not so clear-cut in its origins. The Ministry of Posts and Telecommunications has historically had responsibility for communications and MITI

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* At the request of most persons interviewed, no direct attribution has been made.

for electronics. Both by law and by policy, the functions of the two ministries are defined to avoid overlap, but invariably there is some duplication of effort in the gray area between them. This can be seen most easily in R & D, where overlap is tolerated by the Ministry of Finance to some degree. When this flexibility of function is combined with the lack of a clear definition of what constitutes "information technology," the door is open for MITI to justify its engagement in policy development and in hardware and software R & D concerning information processing even if earlier precedents might have indicated otherwise. In other words, it can be said that MITI has demonstrated convincing adaptability in entering the information technology field.

Communications per se has been and is a vital part of the Japanese domestic infrastructure, but it is a consumer of the products of the electronics industry. The combination is largely a post-war phenomenon, driven by the advent of microelectronics and the computer. It does not, therefore, exactly follow the historical pattern of either complete governmental direction or of heavy reliance upon a supply of technology from the government to industry. An information industry official has stated that his sector does not want government intervention, and that this intervention is not needed if there is an adequate resource base of financing and manpower. He pointed out that in some instances industries need large amounts of capital to begin new ventures. In these cases the industries should approach the Government for assistance, he said, and not vice versa.

MITI apparently sees its role as analogous to that of the Department of Defense in the United States. That is, it looks upon its management of the Japanese industrial economy as a matter of national

security and survival. The problem with this position in the eyes of other nations is that they believe that economic security sometimes must be subordinated to or sacrificed for political or military security. MITI is viewed as being influential in diverting resources away from defense programs to meet its economic security goals. This argument is applied to R & D expenditures as well as to other aspects of the economy. Both MITI and industry officials distinguish between R & D support or assistance from the government to large companies on the one hand and to small or medium-sized companies on the other. The large companies are much more likely to be self-sufficient in R & D, but they are also the ones who are best equipped to participate in MITI-sponsored large projects. The small companies depend on MITI for financial assistance in the performance of R & D and they look upon MITI as a source of basic technology on which they can build. In the information industry there are hundreds of small companies engaged in new product, component, and software development which are likely MITI clients.

There appears to be an uniform view among both government and industry officials as to what kind of research MITI should sponsor. According to both MITI and industry officials, MITI limits its development of technology to that which is applicable throughout an industrial sector and is not in competition with technology being developed on a proprietary basis by individual private companies. This approach is being adopted by other countries and groups of countries that have observed MITI's prior successes. For example, ESPRIT, the French-led European project instituted in response to Japan's Fifth Generation Computer Project, has established "pre-competitive" research goals to be pursued jointly by the participants. MITI-sponsored R & D

in industry is supposed to be dedicated to long-term national goals. It should be of such a high risk nature that the industry itself cannot or is not willing to assume the entire financial burden. In general, this philosophy seems to be carried out in practice. The Electrotechnical Laboratory (ETL) of MITI's Agency of Industrial Science and Technology (AIST), for example, has not undertaken the development of proprietary products independently of the industrial sector, although it is considered a useful and sometimes important organization in supporting the industry with base technology, standards, and consulting services. ETL also can be the originator of novel ideas which are transferred to the industrial sector for full-scale development. It acts as an informal technical link with NTT and Riken (the Science and Technology Agency's laboratory) in the field of information technology. It is probably better able to perform this mission than private companies since it is a government agency.

Forms of Contract R & D

MITI's contract R & D with industry takes two forms: contracts with individual companies to carry out specific objectives; and large-scale projects in which several companies participate through a research association formed for the purpose. In each case, attempts are made to share the costs. There is an incentive for the industry to provide more than 50 percent, since any patent rights that ensue then belong to the company or companies. In Japan, government-owned patents are licensed to the industry only through the payment of royalties. MITI/industry R & D contracts usually have a provision for repayment of the Government's financial contribution if any profits are ultimately derived from the research. There is some question as to how fully this

condition is applied, probably because it could be difficult in some instances to trace profits from sale of a product or products back to a particular R & D project. There would be some logic in examining a company's overall financial condition as well as in trying to exact repayment.

Formulation of Large-Scale Programs Through MITI "Visions"

For any new MITI large-scale program to be brought into national focus, it is almost imperative for it to have surfaced in broad (even vague) terms as part of a MITI "Vision" or long-range indicative plan. MITI's Industrial Structure Council is responsible for generating these Visions periodically, and they represent the first formal tier of consensus among most segments of the society. After MITI has reviewed and endorsed the plan, it is published for public edification. The Visions are usually very positive in tone, stressing improvements in the overall quality of life, increased availability of leisure time, safer working conditions, improved health care, and so forth. These are all designed to be accomplished through the combined efforts of the public and private sectors sometime in the rather indefinite future. While the Visions change in tone, theme, and content from year to year and should not be considered as highly structured blueprints, they are important in revealing the general directions that the Japanese economy and hence the society are expected to take. The Visions cannot fully predict external factors that impinge on the Japanese domestic situation, and they must be adjusted periodically to accommodate this uncertainty and other uncontrollable changes in direction.

A theme often repeated in these Visions over the past decade has been that of an evolving information or knowledge-based society relying

increasingly on information technology. Using the MITI Vision for the 1980's (published in Japanese early in 1981) as an example (53), there are several references to the need for creating better software for use in pattern recognition systems, artificial intelligence, and manufacturing technology, as well as for advanced hardware to be employed for these purposes. Subsequent MITI projects and programs have reflected this projection.

Identification of New Projects

Consonant in time and in scope with the Visions is the process for identifying these new MITI projects or programs. Since MITI officials (except those in AIST) are generalists without long experience in technical fields, they depend on others for ideas which can be combined or synthesized into new programs to meet projected social or economic needs. These ideas come from every quarter: from individuals, companies, industry associations, Diet members, MITI laboratories, and other agencies. Each of these groups interacts constantly with the others, at least when non-proprietary development is involved. The industry-specific MITI bureaus are continuously looking for new technology which should be developed. They follow industry trends both at home and abroad through intimate contact with their particular industrial sector. AIST maintains more of a watch on technology that has across-the-board implications, particularly because of its responsibility for the work performed by the 16 laboratories under its jurisdiction.

After what may be several years of sorting out ideas, combining them into a seemingly reasonable national objective, and obtaining further views from industry associations, Keidanren, and influential

individuals, a new theme is submitted for review by the Industrial Technology Council. Here its potential social impact is determined. If the cost/benefit relationship seems to be suitably positive, then the MITI Minister's secretariat will consider placing a proposal in the MITI draft budget. This will then be submitted to the Ministry of Finance (MOF), taking into account MITI's overall budget posture.

As might be expected, MOF is the most serious hurdle to be overcome. It is entirely possible that even though an impressive consensus has been built and the worth of the idea well established, MOF may delay or even outright refuse to approve such new ventures. Diet approval of the MOF official budget is, however, almost certain.

Once a government-financed R & D program has been initiated, it will be continued over a period of years to its logical and anticipated conclusion. Neither MOF nor the Diet will second-guess the progress made but they will keep reins on the rate of expenditure. This procedure is not applied to each small R & D project. MITI is given some flexibility in initiating and operating a general program of industrial technology development, although it is this program which may suffer during periods of budgetary stringency.

The amount of money allocated for this purpose (see below) is small by American standards. By funding small studies within this program, MITI can develop a detailed planning base for larger programs. An indicator of this intent can be found in the creation of a small office or section within one of the industry bureaus to act as a focal point for consultations with industrial organizations and to begin to acquire the necessary expertise for managing large projects. For example, offices of this kind were created for "space industries" and for "fifth

generation computers" at least two years before MITI obtained approval to embark on the development of a remote sensing satellite or the computer research effort.

MITI's Part in Financing R & D on Information Technology

It is important to examine the magnitude of the MITI effort in the development of information technology. This is best done by initially looking at the financing of R & D in this field. MITI is not the largest government conductor or sponsor of R & D on information technology, being surpassed by NTT (if one accepts it to be a quasi-governmental organization). Also, MITI's expenditures on R & D are only a small fraction of the R & D investment made by industry, and this holds true in the information technology sector. Nonetheless, direct and indirect funding of R & D by MITI for advanced information technology is an effective device for guiding the industry in directions that MITI believes will be appropriate for future economic growth. Hence it is a useful policy tool. Without the financial contribution, albeit small, it is questionable whether MITI would either be as knowledgable about the future of the industry or able to influence the developmental path to its present extent. Whether it is necessary from a national policy viewpoint for MITI to fund R & D on information technology is open to conjecture, since other sources of funds are available. However, most research institutions in Japan, whether public or private, can always use more funding. They are happy to accept MITI grants or subsidies provided not too many strings are attached.

From the published data available, it is almost impossible to make an accurate estimate of the financial investment made by MITI in information technology R & D. This is so for a number of reasons:

-- MITI budget documents do not break out expenditures discretely by this category.

-- There are general budget categories which support several fields of technology.

-- Indirect support of R & D in industry by means of tax credits and other subsidies is difficult to identify by sector.

-- Care must be taken to distinguish among large projects, in-house R & D, research grants, and other forms of direct support.

-- There is no clear-cut definition of what constitutes "information technology," and it may or may not include such things as robotics, flexible manufacturing systems, and other fields employing data processing electronics.

With the above caveats in mind, an attempt will be made to estimate current MITI expenditures in this field based on a detailed analysis published in Japan and translated into English (54). MITI's budget for industrial technology in Fiscal Year 1982 (beginning April 1, 1982) provided the following figures (all amounts in yen have been converted to dollars at a ratio of 240:1):

1. The total MITI budget supporting all forms of industrial technology was $925.4 million.

2. If this amount is broken down into categories of industrial policy, "advancement of the information industry" is shown as receiving $37.1 million, or 22 percent of a larger category entitled "creative industrial technology and knowhow" which amounted to $167.9 million (18 percent of the industrial technology budget).

3. If the industrial technology budget is broken down by sector where the research is performed, government spending -- including the granting of supporting research contracts to industry -- amounted to $565.0 million, or 61 percent of the total. (No break-out of funding for information technology was made.) Corresponding figures for funds granted to the private sector directly were $200.4 million, or 22

percent of the total. Of this amount, $34.2 million was assigned to the information industry. The remaining $160 million, or 17 percent was designated for "miscellaneous" purposes, such as technical cooperation, industrial standardization, and determination of patent rights. Some of this funding must have gone to the information industry.

4. Most of the industrial technology budget -- 95 percent -- is assigned to specific R & D projects. A search of the many projects listed identified the following as being within the category of information technology (dollar figures in millions):

Subject	Amount	Percentage of All Projects
High-speed scientific computer system (continuing project under Large Project System)	$3.4	0.4
Subsidy for dev. of basic technology for next-gen. computer	23.4	2.7
R & D for 5th Gen. Computer	1.8	0.2
Dev. of health care network	0.8	0.1
Subsidy for info. processing project	10.9	1.2

These figures total $40.3 million, or 4.6 percent of MITI spending on technology projects. MITI does not consider the first of these projects as being connected with the information industry, presumably because the computer under development is not viewed as having widespread industrial or commercial applications.

5. Aside from the budget for industrial technology, an additional $191.7 million was budgeted by MITI to subsidize basic preparations for

industrial development through investments by the Japan Development Bank and by tax deductions applicable to research expenses.

Uncertainties in the Budget

From these cross-sections of the budget it is seen that about $37 million was committed directly by MITI in 1982 for R & D specifically identified as related to the information industry. This sum did not include the line item shown for a high-speed scientific computer. It also did not include other line items such as basic software development, optical control systems using lasers, robotics, a flexible manufacturing system, and the remote sensing satellite mentioned previously. These are not considered by MITI to be within the information category.

Even more obscure is the amount of funding applied to research on advanced materials which will have ultimate uses in the manufacture of semiconductors and microelectronic devices of benefit to the information industry. Furthermore, as deduced from the figures above, R & D expenditures within the government laboratories are not broken out by task in budget documents of the type used here. A rule of thumb is that the in-house R & D costs are roughly equal to the amounts spent externally (55), so it appears that a total of about $75 million per year is being spent by MITI directly on R & D related to information technology, as this field is defined by MITI.

Other Budget Estimates for MITI's Investment in Information Technology

How does this estimate compare with other analyses? In its highly informative report on Japanese industrial targeting measures (56), the U.S. International Trade Commission states that a study by Gary

Saxonhouse at the University of Michigan showed that $48 million was provided by the Japanese Government to the industry for computer and semiconductor research and development in 1982 through direct grants, subsidies, and R & D contracts. Considering that the Science and Technology Agency and the Ministry of Posts and Telecommunications (directly or through NTT) also fund industrial research in this area, Saxonhouse's estimate appears to generally conform to the above estimate. In its exhaustive analysis of the Japanese computer industry, the Office of Technology Assessment (OTA) of the U.S. Congress tabulates the MITI R & D budget for computer technology as amounting to $54.1 million in the 1982 fiscal year. The details are in general conformance with the data presented in the previous section, with the notable exception that a figure of $20 million is included for basic software technology development (57). The total is $54.1 million, but OTA notes that its table is not all-inclusive for the field of data processing (and certainly not for the even broader field of information technology).

To demonstrate how easy it is to go further afield, however, science writer Paula Doe (55) analyzed the MITI R & D budget for Fiscal Year 1983 (slightly lower in total than the 1982 budget) and found that $112.5 million had been allocated for "electronics-related budget projects," to which she adds 100 percent to cover research expenditures within the MITI laboratories. The breakdown by percentage of the total demonstrates the problem of definition:

-- Solar energy	24%
-- Software	19
-- Optics	13
-- 5th generation computer	10
-- R & D grants	8
-- Supercomputers	6
-- New technologies	5
-- Space	5
-- Others	10

If the categories of software, 5th generation computer, supercomputers, and R & D grants are added together as a rough approximation of the procedure used in the present study, they amount to 43 percent of $112.5 million, or $48.4 million -- somewhat higher than the estimates presented above. If this number is then doubled, the total R & D direct investment would be about $97 million.

A less direct way of estimating Japanese Government support of R & D on information technology is to examine the expenditures in this field by the industry. While the problem of definition still exists, figures are available for the "communications and electronics apparatus" segment of the industry. In 1979, this segment is reported to have invested 383 billion yen in R & D (58), or $1.60 billion at the conversion rate of 240 yen to the dollar. According to Saxonhouse (59), the Japanese Government provides about 6 or 7 percent of the private R & D expenditure by the computer and semiconductor industry. Arbitrarily using the lower percentage and assuming that it applies to the amount cited, $96 million would have been supplied by the Government. However, this is not MITI-specific and therefore constitutes an upper limit. It

should be compared with the $48 million figure quoted earlier in Saxonhouse's data, recognizing that the data are for different years.

Indirect MITI Subsidies for R & D

Even more difficult to analyze is MITI's policy influence through indirect subsidies of R & D by means of government and tax credits in areas not related to MITI R & D projects or programs but still in the information technology field. Although MITI is not completely responsible for such measures, it is safe to assume that MITI is consulted by other government departments and agencies when they are brought into play -- both in specific cases and in a broader policy sense.

Loans

The Japan Development Bank (JDB), a government instrumentality, is an extremely important agent for the awarding of loans for several purposes, including the development of technology. An American Embassy analysis (60) states that the loans may be more important than their face value because they signal private lending institutions that the recipients are conducting projects consistent with national goals and that they are financially sound. According to this analysis, loans amounting to $458 million were made by the Bank in Fiscal Year 1982 for the development of technology, out of a total of more than $4.8 billion lent. While the category of information technology is not isolated in the breakdown of the $458 million figure, the data show that $47 million went to the electronics industry, $211 million went to the Japan Electronic Computer Corporation (primarily involved in the purchase and leasing of computers), and $191 million went to a general category of new technology development and application. An undefined part of the

last category certainly went to the information industry. The Embassy report states:

> "JDB consults with MITI on every loan. Apparently JDB evaluates a loan application based on standard banking procedures; MITI becomes involved because a firm must submit paperwork to MITI before a loan can be granted. JDB's vice president is a member of MITI's Industrial Structure Council and sits on several subcommittees...."

For further background on JDB's involvement in technology development, the International Trade Commission report (61), a General Accounting Office (GAO) study (62), and a paper by Peck and Goto (63) are recent literature sources.

Tax Credits

A tax credit is allowed in Japan of 20 percent of the increase in R & D expense over the highest previous annual level, up to 10 percent of the company's total corporate tax, according to a Japanese publication (64). The ITC gives a somewhat different interpretation (65). The consequent loss of revenue to the national Government amounted to $122 million in 1981. No figures have been found which define how much of this amount might be applicable to the information industry, but it must have constituted a rather high proportion in view of the heavy R & D expenditures by this segment of Japanese industry.

Special tax measures apply to research associations and thus they may be an incentive for a company to join an association. Corporate members of research associations may completely depreciate fixed assets used in activities of the associations in one year, but the loss of tax revenue has been small. In 1982 only $17 million in losses were attributed to this provision (66).

An Assessment of Fiscal Measures Applied by MITI

Care must be taken in trying to assess the importance of all of these financial assistance measures. The proportion of direct MITI investment in R & D on information technology compared to private investment is small but apparently focused on what MITI believes to be the winners. Indirect subsidies are carefully chosen but the research objectives must be less in the mainstream of MITI interests and may be more justified in terms of the start-up costs of new, small enterprises. MITI's financial plan may fluctuate appreciably from year to year, depending on how many national projects it initiates or is maintaining and how the cost of these projects is apportioned between the public and private sectors. Projections in time of past practices are thus probably unwarranted.

As a matter of national policy, the Japanese Government will be spending more on basic or fundamental research in the future than it has in the past. MITI has had very little to do with this field, leaving it to the Ministry of Education to provide the financing through the university system. Since the national Government has experienced a number of years of severe budget deficits, it may try to look for alternative measures to support increased funding of basic research. For example, could MITI's financial role in R & D be reduced so that more funds could be furnished to other ministries and agencies for this purpose? Such a change might take into account the substantial financial success of the information industry and its ability to fund its own R & D without MITI assistance. Signs are beginning to appear that answers to these questions are being sought by public groups and the Ministry of Finance.

Alternatively, will MITI change the direction of its R & D efforts to emphasize basic research, as it appears to be doing in the Fifth Generation Computer Project? This situation will require further observation over the next five years or so, as existing large projects and programs begin to come to an end.

National Projects in Information Technology

The Rationale for National Projects

MITI's National Project system began in 1966 and is therefore a relatively recent device for focusing money, public attention, and technical manpower on programs believed to be exceptionally important to the nation's future. The emergence of the system seems to have coincided with a recognition that Japan no longer had to borrow technology from other countries and could increase its stature in world competition by a heavier emphasis on domestic development. There were probably other unstated reasons as well, such as organizing selected portions of an industry into a more effective research structure than would result from unbridled and unfocused (as perceived nationally) R & D by individual competing companies. The leverage effect is implicit in the structure of the national projects; that is, injection of a limited amount of MITI funds can make the difference between the industry pursuing an R & D objective which is long-term and of relatively high risk or looking for shorter term projects that have more predictable payoffs.

Industry and MITI Views of the National Project System

The national projects have attracted world-wide attention, usually because they are viewed as overt evidence of MITI's strong control over Japanese industry and its attempt to target specific industries for growth and effective international competition. Interviews with industry officials in Japan do not support this contention. Ordinarily these officials would be openly critical of MITI efforts to interfere with private enterprise to such a great extent, but they point out that the scope of most of the national projects originates from the

industrial sector itself and not unilaterally from MITI. They also point out that the importance of MITI in setting R & D goals has declined with the passage of time as the Japanese industrial economy has strengthened. Usually overlooked by non-Japanese is the much heavier private and competitive R & D investment being made by companies working in the field of interest, the results of which are often not pooled or shared with others. MITI officials claim that the intent of the national projects is to develop common technology applicable across an industrial sector and not aimed at a specific product. Industry representatives support this claim, and note that the creation of a national project cuts two ways: corporations wish to be invited to join a given project because they do not want to be left out of developments which may have a significant impact on their industry, while those who are not invited or permitted to join are determined to keep apace by increasing their R & D expenditures.

General Application of the National Project Approach

The MITI national projects are, of course, directed toward one industrial sector or another. When this sector is successful, there is a logical assumption drawn by outsiders that MITI's intervention or involvement was a key factor in the achievement. What is not taken into account in this type of reasoning is the success of those technologically oriented industries or individual corporations in Japan which have not been involved in a national project related to their field. Matsushita Electric Industrial Company (National Panasonic), Sharp, and Sony are three examples of companies in the information technology field which have achieved notable success both in innovation and in sales without major involvement in the MITI projects. These

three consumer-electronics companies are post-war phenomena and do not trace their origins to the zaibatsu or industrial cartels that were the precursors for the other giants of the Japanese electronics industry. As such, they are still considered to be outsiders by some government officials.

Stated another way, a great part of the strength of the Japanese industrial economy -- in such fields as automobiles, consumer electronics, and pharmaceuticals -- was built up without direct R & D support from MITI and certainly not through the use of the national project approach.

This reasoning also fails to take into account those national projects which do not meet the expectations of the MITI planners. All of the projects have contributed to the gross national technological base and have therefore been worthwhile to a degree. But one of the weaknesses of the MITI approach is its heavy reliance on concluding many of the national projects with the construction of a demonstration system, pilot plant, or some other physical manifestation of the R & D. This has certain political advantages, but the industry believes that the funds so invested could be better spent. Speaking generally, the demonstration systems have not led directly to their replication by the industry as industrial products or processes. They are not failures in the Japanese frame of reference, but neither are they the ultimate commercial successes postulated by outside observers.

Diffusion of Technology from Large Projects

AIST employs another figure of merit to measure the successes of its national projects. It monitors the number of requests received from industry for use of proprietary or patented information that has been

developed through the projects (67). By March of 1982, 2,374 domestic applications and 192 foreign applications had been received. Since the Japanese Government does not disseminate proprietary information or license its patents free of charge even to Japanese entities, AIST received a total of 295 million yen (or $1.3 million) in revenues from these applications. While the number of applications appears large, the amount of revenue appears to be almost trivial. AIST had invested 150 billion yen ($652 million) in its large projects from 1966 to 1982, so licensing fees hardly constitute a monetarily worthwhile return. In all probability, the cost of maintaining the licensing system exceeds the revenue received. MITI obviously uses other criteria to measure the worth of its large R & D programs.

A Comparison with the U.S.

The U.S. government does not provide financial support for industrial R & D in anything like the manner found in Japan, although industrial or private research organizations perform much of the R & D sponsored by the Government. The difference is that historically the U.S. Government has taken the position that private enterprise should assume the burden for industrial R & D except in programs of such magnitude or national importance that Government intervention is warranted and justified. National security, public health, environmental protection, aerospace, new energy technologies and agriculture are six areas where U.S. government involvement through R & D has been exceptionally heavy. Private industry has benefitted from this involvement in a somewhat indirect way by finding means for applying the technology developed to industrial processes or products. The term "spin-off" applied to this form of technology transfer reflects its indirect nature.

Advocates of a national industrial policy for the United States tend to want to move more toward the Japanese system of providing R & D support for industry, but it is still too early to tell if the industry itself would welcome this move. There seems to have been no fundamental problem with acceptance by the industry of government funds for R & D in the public benefit, even when the investment led directly to commercialization. For example, the U.S. Government invested very large sums in developing alternative types of nuclear power plants, including constructing demonstration plants of each type. Ultimately, only three commercially viable types survived the resulting economic and technical competition, although a large body of useful technical information was generated.

In more recent times, the U.S. Government has appeared to be in favor of financially supporting the development of technology with heavy commercial implications in a few instances as outgrowths of security or space interests. For example, the Defense Advanced Research Projects Agency (DARPA) is embarking on a program to develop supercomputers. The program seems to be modeled after a Japanese effort in this direction and may be designed to result in hardware which can compete with Japanese machines internationally. This subject will be addressed further below.

National Projects Concerned with Information Technology

Further discussion of the use of national R & D projects as a policy tool by MITI will be focused on their application to information technology.

Both the Agency of Industrial Science and Technology (AIST) and the Machinery and Information Industries Bureau (MIIB) of MITI sponsor

national projects on information technology. The line between them is loosely drawn. AIST tends to be more interested in R & D not directly related to computers, while MIIB concentrates on the computer and microelectronics field. However, this is not a hard rule. AIST has sponsored a total of 20 large-scale projects, of which eight are still under way (68). Depending on the definition employed, five of the eight projects may fall in the category of information technology. They are:

1. "Flexible Manufacturing System Complex Provided With Laser." Period: 1977-84. Total budget: $57 million. Scope: Development of a complex production system using robots and laser cutting tools for manufacturing small batches of metal parts.

2. "Optical Measurement and Control System." Period: 1979-1987. Total budget: $75 million. Scope: Development of an optical/electronic system for measurement, observation, and control of mass information (including visual) in specific applications areas under conditions adverse to conventional systems.

3. "Scientific Computing System." Period: 1981-89. Total budget: $96 million. Scope: R & D on high-speed computer system for processing scientific and technical information at real-time rates beyond the capacity of existing computers.

4. "Automated Sewing System." Period: 1982-89. Total budget: $54 million. Scope: Development of an automated sewing system for the apparel industry to meet needs for rapid diversification and changes in domestic demand.

5. "Advanced Robot Technology 'Jupiter'." Period: 1983-90. Total budget: $83 million. Scope: Development of a robotics system which can operate in hazardous environments.

In addition, AIST has instituted a more general project called "Research and Development Project of Basic Technologies for New Industries" which is applicable to almost the entire industrial sector (69). Probably for this reason, it is not identified as a "Large-Scale Project." It is analogous to AIST's long-standing "Sunshine" and "Moonlight" programs for the development of alternative energy sources and energy conservation technology respectively. Neither of these programs are defined strictly as Large-Scale Projects.

The Basic Technologies for New Industries project contains three program categories: new materials, biotechnology, and new electronic devices. The last has obvious implications for information technology. The lifetime of the project is estimated to be about 10 years (starting in 1981). About $6 million per year is being spent on the development of new electronic devices. Also, the program element concerned with new materials is expected to lead to the development of ceramics and other materials that have applications in the information technology field.

Under the aegis of the Machinery and Information Industries Bureau, the only national project related to information technology believed to be in operation at the present time is the Fifth Generation Computer Project. This promises to be the most controversial of all MITI-sponsored R & D efforts. MIIB appears to have completed its investment in a software automation project (1976-1981) and a fourth generation computer project (1976-1983) which included the internationally publicized VLSI development program. The VLSI program was identified in the U.S. and other countries as a prime example of MITI industrial targeting practices.

AIST's completed projects on information technology have involved the development of a high-performance computer (1966-1971) at a total cost of 10 billion yen; a system for analyzing and controlling automobile traffic in congested areas (1973-1979) at a total cost of 7.3 billion yen; and a pattern information processing system for recognition and electronic or optical transmission of kanji characters and other information forms (1971-1980) at a total cost of 22 billion yen.

Evaluation of Completed Information Technology Projects

A report by the American Embassy in Tokyo has analyzed a number of the projects listed above which fall strictly in the category of computer, software, and microelectronics R & D (70). Further information appears in a large number of other publications, of which a sampling will be cited in an attempt to determine the policy nature and effectiveness of the national project concept. Additional views have been obtained through interviews with Japanese officials. Purely technical details and accomplishments lie beyond the scope of this study.

Early Computer Projects

The nature of the large-scale information technology projects has changed with time, in conformance with the period characterized by one analysis as ranging from "catch-up" to "innovation" (71). The first such project, the development of a high-performance computer, was an outright attempt to support the nascent Japanese computer industry in achieving a technical level equivalent to that of IBM (72-74). It led directly to another large-scale project (the next-generation computer project) wherein MITI exerted its influence to restructure the Japanese large computer industry into three centers of power (68,75), again with the objective of meeting or exceeding IBM's real or perceived technical prowess. The need for a foreign target seems to have dominated MITI's policy planning during the 1960's and '70's: first the IBM 360 Series, then the 370, and finally -- when no numerically designated IBM large computer system appeared on the scene -- what the Japanese called simply "FS," for future system. Each was a successive performance target for Japanese systems. (This supports the contention by many observers that

Japan has always been more comfortable playing the catch-up role than in being the leader in a particular technical field.)

Each of the three industrial consortia ultimately put their own versions of a large computer roughly equivalent to the IBM 370 series on the market, but IBM had not stood still and new targets had to be established for the Japanese computer industry. Although production of the computers was subsidized financially by the Government, the three parallel paths did not take place entirely within the National Project.

A MITI analysis of the impact of the 1966-1971 project states: (65)

> "The results not only have been utilized in many ways in domestically produced large electronic computers but they have greatly raised the technological level of electronic computers and semiconductors, closing the gap in technology between this country and the West and contributing greatly to the technological foundation for today's developments."

The unprecedented size and complexity of the first national project led to the formation of a management system which was to be followed in subsequent large projects. That is, appointment of a senior counsellor in AIST to oversee it; participation in technical management, systems design and semiconductor R & D by AIST's Electrotechnical Laboratory; the use of two especially established research associations; and the involvement of the Japan Electronics Industry Development Association (JEIDA). In subsequent years the Information Technology Promotion Agency (IPA) and other industry associations became factors in the planning and execution of the computer-related national projects.

The Pattern Information Processing System (PIPS)

Another of the earlier national projects deserves some special attention, because it marked MITI's first attempt to embark on a very large innovation task. The title of the project was "Pattern Information Processing System" (PIPS). During the course of carrying

out the high-performance computer project, AIST and the computer companies involved began to realize that they had not made sufficient allowance, either in time or in money, for the development of input/output hardware for the computer concept. What was missing particularly was sufficient flexibility to handle Japanese language programming, printing, and data transmission. Consequently, an add-on project was created which was highly technical in scope and which did not meet any real commercial marketing criterion. According to one analysis (1), the project was allowed to proceed without a true understanding of its implications or complexity by the various MITI councils and advisory groups. These groups tended to view projects in economic terms only.

The PIPS Project began in 1971 with a planned eight-year execution period and a budget of 35 billion yen -- substantially more than the computer project. It proved to be an exceptionally difficult set of tasks, considering the general state of development of input/output devices at the time. In due course the project's budget was reduced to 22 billion yen and the execution period was extended to 10 years. Even by the time of its completion in 1980, it had attracted very little international attention, perhaps because it was so heavily tied to the written and spoken characteristics of the Japanese language. The original intent was to conclude the project by demonstrating a prototype commercial system in accordance with MITI's proclivity for demonstrations, but apparently only less sophisticated models were completed. The project faded from sight without fanfare.

According to a senior industry official, MITI considered the PIPS Project to be a failure, but the industry took a different view. It

appreciably advanced the level of knowledge of input/output devices and established the technical base for the emergence of such practical equipment as kanji word processors which are now entering the Japanese domestic market at a rapid rate.

Some of the objectives of the project have still not been met. For example, the use of spoken natural language for computer commands and output was not fully developed, but this will be a part of the Fifth Generation Computer Project. Thus the research performed under the PIPS project will not be lost. It is interesting and perhaps no coincidence that the director of the Fifth Generation Computer Project previously headed the Electrotechnology Laboratory's part of the PIPS project.

George Lindamood, formerly with the Tokyo branch of the U.S. Office of Naval Research, evaluated the project in these words: (74)

> ".....[T]he project should perhaps be regarded as an on-the-job training exercise in which a number of bright, young Japanese engineers were exposed to the state of the art in the various technical areas involved. If such is the case, then this project ..... should not be judged in terms of the resulting prototype nor even the commercial spinoffs (such as NEC's voice recognition unit) but rather in terms of the products developed by the project 'alumni' in the ten years (or so) after the project was terminated."

The Office of Technology Assessment also gives relatively high marks to the PIPS project, stating: (75)

> "PIPS has been much less visible in the United States than several of Japan's other R & D efforts, but it played a major role in laying groundwork for the fifth-generation computing project."

During the field work conducted for this study, MITI officials were asked for their own internal evaluation of PIPS. They responded by providing an informal document in Japanese which has been translated and attached to this report as an Appendix. MITI's assessment indicates that various technical successes were achieved:

1. A device for reading 2000 Chinese characters (kanji) at a rate of 100 characters per second was developed successfully -- the best performance achieved by any system at that time.

2. A system for processing satellite photography was developed which could electronically scan a black-and-white diagram in 0.3 second; a related system for color photographs taken by aircraft was able to scan a photo in one second. The equipment developed was integrated in a national topographical survey system.

3. A system for optically scanning three-dimensional objects and identifying them by their shape was developed and subsequently applied to inspection of chips on integrated circuit boards.

4. A device capable of identifying 100 spoken words with high accuracy was developed successfully, leading to several commercial applications.

5. The world's first data base machine employing magnetic bubble memory was demonstrated.

The MITI report makes the best of the attempt to demonstrate an overall system prototype by noting that the prototype was used for evaluation tests. It concludes that the project established the fundamental technology for pattern information processing and that a significant contribution was made to the upgrading of Japan's information industry. Thus it confirms the views of industry officials about the value of the component technology developed, while indirectly acknowledging that the overall system prototype did not perform well enough to be adopted as a commercial unit.

One of the more informative articles on Japanese industry and technology appearing in the U.S. business press during the past three years (76) gives very high marks to PIPS, labeling it:

> "....a casebook study of how MITI's support and management of R&D produces coordination, efficiency, and results that could not be matched by a group of competitive manufacturers operating independently."

While this may be an acceptable judgment in hindsight, it is doubtful that the project received such acclaim either within MITI or outside during the mid-1970's. MITI undoubtedly learned a good lesson from PIPS, however: investment in basic, long-term R&D can have unexpected returns which are worthwhile in their own right. The Fifth Generation Computer Project and the Research and Development Project of Basic Technologies for New Industries are both given broad objectives by MITI. Everyone concerned with these projects makes it clear that the objectives do not have to be explicitly fulfilled for the projects to be considered successful. Thus Japan appears to have moved from its catch-up phase in information technology development to a creative phase.

International Impact of Other Projects

It is not necessary for the purposes of this study to go into the details of all of the other large projects concerned with information technology. They have varied in their degree of success, the amount of controversy they have caused, the extent and methods of financing industrial participation, and the degree to which they have attracted international attention. Using these factors as criteria for judgment, the project for developing manufacturing technology for very large integrated circuits (VLSI) during the 1976-1980 period was one of the most important.

The VLSI Project

The VLSI Project was seen in the United States as an example of MITI's "unfair" support of industrial R&D and was the cause of friction between the U.S. and Japanese semiconductor industries. In retrospect,

it was viewed abroad as the reason for Japan's success in capturing a large share of the world market for 64K dynamic RAM chips. In Japan, however, representatives of both government and industry reject this claim. They point out that several Japanese companies were developing their own proprietary forms of 64K RAM chips during the term of the project and that the chips came on the market too early to have been the result of the project. They further state that the full impact of the VLSI Project is still to be felt.

In fact, the VLSI Project was not concerned with the development of chips but with the development and testing of equipment for manufacturing chips, in conformance with the usual MITI approach of assisting with shared industrial technology (77, 78). In this sense the results of the project will continue to be important for a long time.

There seems little doubt that the VLSI Project stimulated the U.S. Government to provide even larger financial support for the similar VHSIC project carried out under DOD auspices in government, industry and academic laboratories to develop semiconductors said to be needed for military applications. The VLSI Project in Japan also was a major factor in influencing the Semiconductor Industry Association (SIA) of the United States to organize a research consortium. It was also held as a justification for creating the Microelectronics and Computer Technology Corporation (MCC), a joint research venture of American companies. None of these American counter-efforts follow the organizational, funding, staffing, or information dissemination patterns of the Japanese precursor.

The Japanese VLSI Project was unusual for its magnitude* and its organizational structure. A research association was established that actually operated a joint research laboratory for the specific purposes of the project. It was disbanded upon completion of the work. Although Nippon Telegraph and Telephone (NTT) was developing VLSI circuitry and chips in its own laboratories, it acted as an advisor to the project and may have carried out some of the research. This indicates a continuing improvement in the relationship between MITI and the Ministry of Posts and Telecommunications (MPT) or NTT. In years past, MITI would have been considered an interloper or competitor, and direct cooperation would probably not have been possible.

Most of the foreign literature references which have been cited in this study contain further information about the details of the VLSI project and the consequences attributed to it.

Comprehensive accounts and analyses have been prepared at the MIT Sloan School of Management by Sakakibara (79) by an American-Japanese team at Stanford (80-82), and by the Office of Technology Assessment (77, 83). Earlier Japanese views of the project are contained in a series of translations published by the U.S. House of Representatives (84).

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*MITI invested $323 million through conditional loans to be paid back from any profits which accrue in the industry from use of the developed technology. The industrial concerns involved supplied more than an equal amount of private funds.

The Fifth Generation Computer Project

Although it is still in its infancy, literally volumes have been written about MITI's latest and potentially largest national project, the Fifth Generation Computer Project. Part of this attention is due to the sensitivity created by the economic successes achieved by Japan in computers, microelectronics, and related parts of the information technology field. There has consequently been fear that the project will lead to Japan's wresting from the U.S. its current domination of the world computer market. This fear is often expressed in terms of national security (85,86).

The Fifth Generation Computer is more of a concept than a machine at this stage. It is not considered to be merely a larger version of computers now in existence or under development but to be a system that can communicate directly with humans and that can draw logical conclusions from inferences presented to it. Even if only a few of its functions prove to be successful after the initial development period of 10 years, its Japanese sponsors have said that the large investment (at least $400 million) will have been worthwhile.

For the purposes of this study, the project is important for several reasons. It marks a decided change in the R&D policy direction by MITI in that it encourages international involvement*. It is heavily oriented toward basic rather than applied research. It breaks down the compartmentalization of the government bureacracy more than have previous projects. Lastly, it is publishing the results of current

* This move is viewed with suspicion by a number of other countries. They have expressed fears tht cooperation will lead to Japanese absorption of foreign technology without compensating benefits to the foreign participants.

research in English. No doubt part of the rationale for this approach is to counter foreign objections to previous large-scale projects, but a project of this magnitude cannot be justified in Japan on this basis alone. If it is successful to a reasonable degree, it could put Japan at the leading edge of computer and information technology and well into the still uncertain field of artificial intelligence. In broader terms, it will have been a stimulus to creativity and innovation, heretofore not considered to be Japanese strong points.

It is too early to assess prospects for the success of the Fifth Generation Computer project. If sufficient accomplishments are made within the next two to five years, MITI may feel pressed to revert more to a hardware-oriented course. This would entail limiting foreign participation and placing heavier emphasis on protection of proprietary information. If this in fact occurs, objections probably will be heard from abroad, but they may be somewhat muted in recognition of the openness with which the project has been initiated and the extent to which it has been explained in English by the Japanese Government and the participants (87-90). Most of the literature already cited mentions this project. While capturing the most public attention, Feigenbaum's book (41), should be considered in the context of many other works on this subject.

Concluding Comments

From the foregoing, the following picture emerges of the part played by MITI in the development of information technology.

Contrary to the popular view of MITI as the autocratic manager and financier of all sectors of the Japanese industrial economy, MITI has been a relatively small participant in influencing the course of development of information technology through direct financial support of R & D in this field. In general, funding for industrial R & D in Japan comes far more from the private sector than from MITI or other agencies of the Government. MITI's broader economic policies have affected the course of Japanese success in computers and communications and for this reason alone the importance of MITI cannot be denigrated.

From MITI's point of view, it has assumed a major part of the responsibility for carrying out the development of future information technology, although it has not established itself as the primary factor in this endeavor. It is, in fact, considered more or less an interloper by some in Japan. The Ministry of Posts and Telecommunications and the government-controlled Nippon Telegraph and Telephone Public Corporation remain dominant public organizations in the communications field. Other Government ministries and agencies make technical contributions as well. Private industry in Japan appears capable of conducting its own R & D on information technology without either guidance from MITI or its financial support, but MITI tries to focus the direction of this research to avoid unnecessary duplication and to meet perceived national needs.

MITI by itself is not responsible for Japan's economic success. Rather, its forte appears to be its ability to bring divergent points of

view together in creating national policies that are generally acceptable to the various sectors of the society. Consensus-building remains one of the striking features of the Japanese scene. Japan's and MITI's successes in the post-war era have been due in large part to the political stability that has been enjoyed. This stability has enabled MITI to perform its role of guidance and coordination in an effective manner.

By U.S. standards, MITI is a small government organization, in terms of both budget and personnel. Its closest analogue in the U.S. is the Department of Commerce, but the analogy is not close. For example, MITI has heavy energy responsibilities and Commerce does not. MITI is about one-third the size of Commerce and somewhat smaller than the Department of Energy. About 30 percent of MITI's employees are located in its Agency of Industrial Science and Technology and subordinate research institutes. This agency has a budget of about $500 million per year, of which only a small fraction is spent on the development of information technology. However, MITI's interest in information technology is reflected in the large number of other bureaus, sections and offices which have responsibility for one facet or another of the development and application of information technology. They collect statistical data on industrial products; plan comprehensive policies for the electronics and allied industries; promote the use of computers and cultivate the development of software and data processing services; control the export and import of electronic machinery, including communications equipment; make R & D loans and grants to industry; maintain a National R & D Program; set national industrial standards; and control issuance of patents. In addition, MITI sponsors large-scale

National Projects combining the R & D capabilities of several industrial organizations and government laboratories. A number of these projects have been in the field of information technology and have attracted international attention. However, only about 10 percent of MITI's industrial technology effort is concerned with the information sector.

The effectiveness of MITI is not measured by its budget or its size but by the web of communications and coordination that MITI has established with the private sector. Two industrial advisory councils form direct links. One of them prepares the MITI "visions" which set the long-term course of industrial development in Japan and the other evaluates the state of industrial technology, including information technology. Hundreds of industry-specific trade associations exist under MITI auspices, and of these, many are connected with information technology. On occasion research associations are formed by MITI to conduct large-scale government/industry projects. The entire network is the most unusual facet of MITI's interaction with industry.

With the advent of an era marked by Japan's broad economic success and by inroads made in world markets by the Japanese information industry in particular, MITI's role in sponsoring R & D on information technology through both fiscal and administrative measures may change either toward support of research which is more fundamental in character or toward a much lower level of involvement. Hard decisions in this regard have not yet been made.

The MITI structure for the development of industrial technology cannot necessarily be duplicated in the United States, but there is no reason why useful elements of this structure should not be used in the U.S. to improve industrial performance.

Appendix

Translation of MITI/AIST's Evaluation of the PIPS Large-Scale Project

A Summary of the Evaluation Report Concerning Research and Development of the Pattern Information Processing System. Prepared by the Research and Development Office, General Affairs Division, Agency of Industrial Science and Technology, MITI, June, 1981.

1. Summary

Research and development of the "Pattern Information Processing System" was implemented in order to secure the necessary technology in new electronic computers as envisioned for the 80's. This R&D is to facilitate the wide-range utility of electronic computers as will be required in the ever expanding information oriented society and in order to meet the demands of the high precision information industry, and also to strengthen [Japan's] international competitiveness. The objective of the research is to develop high technology and processes capable of directly identifying and processing patterns of information obtained from letters, diagrams, objects, and voices (natural dialects).

a) R&D duration: 10 years, FY 1971-1981.

b) Total R&D investment: Approx. 22 billion yen.

c) R&D program:

In order to create a direct input of pattern information and to identify, memorize, operate, and process it, new materials, devices, information processing systems, and pattern identification methods were developed and a pilot model was

produced. Further, a performanceevaluation test run of a total system which included the results of the above-mentioned developments combined with the respective identification systems and information processing systems was conducted.

2. Main R&D Achievements

a) Letter identification:

A system was developed capable of identifying about 2000 printed letters, including kanji, at high speed (100 letters/second). For handwriting, a system was developed capable of identifying the [Japanese] syllabary, numerals and katakana (approx. 100 letters) at high speed (400/second). This recorded Japan's highest level of letter identification technology.

b) Diagram [graphic] identification:

For black and white diagrams, a high speed system (0.3 second) was developed to process satellite photography information (512 x 512 picture size). For colored diagrams, a high speed system (1 second) was developed to process information from aerial photography (256 x 256 picture size). For an application of this technology, these results were integrated into a national topographical [land] survey system which proved that a practical diagram identification was feasible.

c) Object identification:

A system capable of identifying within approximately 10 seconds a corrugated cardboard box with a complicated background and surface pattern was developed. For application, a system was developed to inspect within approximately 0.4 seconds the types of IC's boxed in printed panels and [to detect] installation errors, thus proving the feasibility of practical production.

d) Voice recognition:

A system capable of identifying individual spoken words (approximately 100 words) by an unspecified number of voices was developed. In terms of number of words and identification ratio, the devised system is at the world's highest level. Furthermore, continuous voice/sound identification, together with a natural dialect processing system, has produced a number of achievements in the field of input and output of daily vocabulary.

e) Overall system prototype:

An overall system prototype was constructed which connected these sub-systems with information processing systems such as poly-processor systems, parallel operation machines, and high-level word machines through a high speed ring bus system employing optical fibers. This system was then used

to perform capability evaluation tests on various applications.

f) Others:

Practical magnetic bubble memory (256K/chip), LSI memory (16K/chip), and a microprocessor (PULCE) were configured into the world's first data base machine using magnetic bubble memory.

In addition, a picture sensing device and a high speed ring bus system based on a semiconductor laser were developed.

Also, a multiple assembly of calculators and processors which processes high volume data through various microcomputer systems was developed.

3. Evaluation

The objectives as outlined in the basic schedule were almost all achieved, and it is recognized that the fundamental application technology necessary for pattern identification and processing has been established.

Technologies which attained commercialization during the R&D period were magnetic bubble memory, LSI memory, and optical letter reading (for handwriting) systems. Printed letter reading, voice identification, and picture processing (diagrams and objects) are expected to reach practical application and commercialization in the near future.

During the period which led to the building of a total system prototype, a number of positive results were gained in identification and information processing sub-systems, thereby making a significant

contribution to the upgrading of Japan's information industry.

(Reference)

1. Examples of [future] R&D applications

[Not reproduced here for the sake of brevity]

2. The overall system prototype was awarded the 1980 "Prime Minister's Citation for Japanese Industrial Technology" Grand Award, sponsored by the Nikkan Kogyo Shimbun, as public recognition of the significant contribution made in the field of pattern information processing systems.

3. Industrial properties

a) Domestic patent applications: 494 (including those of ETL)

b) License agreements: 711 (to FY 1980)

c) Knowhow assignments: 711 (to FY 1979)

d) Academic reports: 1980 (to FY 1980)

4. Description of terminology

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[Overall schedule and block diagram of system prototype not reproduced here]

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