

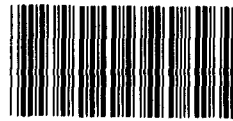
GAO

Report to the Chairman, Subcommittee on
Defense Industry and Technology
Committee on Armed Services, U.S. Senate

March 1992

FOREIGN TECHNOLOGY

Federal Processes for Collection and Dissemination



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United States
General Accounting Office
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National Security and
International Affairs Division

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The Honorable Jeff Bingaman
Chairman, Subcommittee on Defense
Industry and Technology
Committee on Armed Services
United States Senate

Dear Mr. Chairman:

In response to your request, we examined the use of foreign technology information by key U.S. officials and industry representatives. Specifically, we (1) determined the extent to which these key officials and industry representatives used five federal processes for collecting and disseminating foreign technology information, in general, as well as in developing the federal critical technologies lists, (2) identified the sources and nature of the foreign technology information that has been used to develop the federal critical technologies lists, and (3) obtained the views of U.S. officials and industry representatives that played a major role in developing the lists regarding opportunities to improve federal processes for collecting foreign technology information. As requested, we are also providing information on (1) the disparity in the number of researchers¹ and students exchanged between the United States and Japan and (2) the nature of selected U.S. private sector efforts for collecting and disseminating foreign technology information.

Background

The National Critical Technologies Panel,² the Department of Defense (DOD), and the Department of Commerce have each developed lists of critical defense-related and commercial technologies of significant importance to the U.S. national interest. The National Critical Technologies Panel's first report, released on March 22, 1991, described 22 technologies

¹"Researcher" refers to scientists and engineers at the graduate level and beyond who spend time engaged in research.

²The National Critical Technologies Panel was appointed by the Director, Office of Science and Technology Policy, Executive Office of the President and included representatives from six federal agencies: DOD, Commerce, the National Aeronautics and Space Administration, the National Institutes of Health, the Department of Energy, and the National Science Foundation. The Panel also included five representatives from industry and academia, such as AT&T Bell Laboratories, Martin Marietta Corporation, and the Massachusetts Institute for Technology. This Panel is required by the fiscal years 1990 and 1991 Defense Authorization Act, Section 841 of Public Law 101-189 amended Title VI of Public Law 94-282, 42 U.S.C. 6683, to biennially report on critical technologies for the United States. The purpose of these reports is to increase government and industry awareness of the crucial role of technology in achieving national goals.

considered essential for U.S. long-term security and economic prosperity. DOD's 1991 Critical Technologies list, the third such list developed annually as part of DOD's Critical Technologies Plan, described 21 technologies that are required to maintain the qualitative superiority of U.S. weapon systems. Commerce's Emerging Technologies Report, issued in 1990, identified 12 technologies that have the potential to create numerous new products and services and to substantially advance the productivity and quality of American industries.

Our 1990 report³ identified the various federal processes for collecting and disseminating foreign technology information, ranging from raw data collection to the development of highly detailed foreign capability analysis. However, as you requested for this report, we focused on five particular processes. They are two of the Defense Intelligence Agency's (DIA) past projects, Project SOCRATES and World Technologies Database, DIA's newly initiated National Industrial Security Program Information Management System (NIMS), and two federal clearinghouses⁴ that collect and disseminate foreign technology information, Commerce's National Technical Information Service (NTIS) and DOD's Defense Technical Information Center (DTIC).

Results in Brief

U.S. officials and industry representatives that played a major role in developing the three critical technologies lists told us that the foreign technology information collected by three of the federal processes we examined was not directly used in developing the lists. The other two processes, Project SOCRATES and NIMS, were not in operation when the lists were developed. They also noted a number of broader concerns about the general usefulness of the data from these processes and their accessibility. They provided the following reasons for their position. Information from Project SOCRATES and World Technologies Database contained classified and proprietary information that limited its dissemination. The foreign technology information available from federal clearinghouses, such as NTIS and DTIC, is generally neither current nor specific enough to meet the needs of policymakers and industry representatives. NIMS is currently in development; therefore, information on its usefulness was not available.

³Foreign Technology: U.S. Monitoring and Dissemination of the Results of Foreign Research (GAO/NSIAD-90-117, Mar. 21, 1990).

⁴A federal clearinghouse is a central point where information that has been collected by federal agencies, contractors, etc., is gathered and made available to interested parties.

Those developing the federal lists of critical technologies used various sources of foreign technology information, including briefings from government agencies and private sector experts, intelligence sources, and knowledge gained from discussions among themselves. Some National Critical Technologies Panel members said that the nature of the foreign technology information they were provided focused on economic and military perspectives relating to technological developments, but the information was often too general. They said that the knowledge gained from discussions among panel members was very valuable. Officials who developed the DOD and Commerce lists relied mostly on the information obtained from their own agency experts supplemented by data from intelligence sources.

U.S. officials and industry representatives suggested that the quality, quantity, and timeliness of the foreign technology information available through federal processes could be improved through more and better personal interactions between U.S. and foreign researchers. They also suggested several other opportunities for the government to improve its processes such as doing more market research to identify the needs of both the users and potential users.

Available data indicates that over twice as many Japanese researchers work and study in the United States for 1 month or longer as U.S. researchers work and study for comparable periods of time in Japan.

According to the Chairman of the National Critical Technologies Panel, private sector efforts are generally more successful than government efforts to collect and disseminate foreign technology information because they are more focused toward the needs of their clients.

Usefulness of Federal Processes That Collect and Disseminate Foreign Technology Information

It is generally recognized that the collection and dissemination of foreign technology information can be integral to improving the competitive advantage of established industries and competing successfully in new industries. Information about technology, markets, and competition influences the decisions of policymakers and firms; helps in identifying opportunities for technology application and commercialization; and exposes threats, such as the potential loss of market share.

Government officials have acknowledged that a major challenge confronting the United States is to develop and maintain mechanisms for enhancing the access to and usefulness of foreign technology information

and to bring that knowledge to bear in increasing the competitiveness of U.S. industries. That knowledge, coupled with a strong industrial infrastructure, capital investment, domestic technical capability, and an educated and motivated work force, are key to a nation's economic growth.

Table 1 provides information on the five federal processes we examined, including their current status and their intended purposes.

Table 1: Selected Federal Processes

Agency, name of process, and status	Intended purpose
DIA Project SOCRATES (Terminated in 1990)	<ul style="list-style-type: none"> - Provide strategic level science and technology capability for the United States - Provide information for export control purposes - Track technologies relating to equipment, materials, and know-how
DIA World Technologies Database (Terminated in 1991)	<ul style="list-style-type: none"> - Provide strategic level science and technology capability for the United States - Provide information for export control purposes - Monitor and store foreign technology information collected from various sources
DIA NIMS (Initiated in 1991)	<ul style="list-style-type: none"> - Distribute information among agencies with Foreign Ownership, Control, or Influence^a responsibilities - Enable federal agencies to share data and reduce redundant collection efforts
Commerce NTIS (Ongoing)	<ul style="list-style-type: none"> - Make available to subscribers the results of research developments from its primary sources
DOD DTIC (Ongoing)	<ul style="list-style-type: none"> - Act as DOD's central collection and distribution point for defense-related science and technology information

^aAgencies with Foreign Ownership, Control, or Influence responsibilities include: the military departments and other DOD Components, the Departments of Commerce, Treasury, State, and Energy, the Central Intelligence Agency, the National Security Agency, and the Federal Emergency Management Agency. DOD is mandated to be the lead agency responsible for NIMS in Presidential Directive 10865.

Despite the importance of foreign technology information, U.S. officials and industry representatives told us that the foreign technology information collected by three of the federal processes we examined was not directly used in developing the lists. The other two processes, Project SOCRATES and NIMS, were not in operation when the lists were developed. In addition, the officials said that the processes were not considered to be of great use, in general, and were not always accessible.

Project SOCRATES was a classified DIA foreign technology information system that was in development and limited operation from 1984 to 1990.

According to DIA officials, when the project was in place, the process of obtaining information through it was lengthy, time consuming, and expensive, and the program was eliminated due to DOD budget constraints. DIA used World Technologies Database as an interim system to store and analyze the aggregated foreign technology information collected by DIA from both open and classified sources. The information was limited to data on flat panel displays and was not widely disseminated because the data base was classified. NIMS is a newly initiated DIA system that was not available for use during the development of the federal critical technologies lists. It is expected to enable federal agencies to share data and reduce redundant technology collection efforts. However, U.S. officials indicated that NIMS information will not be widely disseminated, because it will contain classified and proprietary data.

Several U.S. officials and industry representatives said that the foreign technology information available through federal clearinghouses is generally not current, and in some cases, not analyzed or specific enough. The officials suggested that these clearinghouses may need to do market research to identify the needs of the users as well as the potential users' receptivity to these services. NTIS officials stated that NTIS is not reaching its potential U.S. market and is expensive to users because its activities are required to be self-supporting, there are difficulties acquiring translated materials, and public awareness of NTIS services is limited. Accessibility of NTIS information is limited because it is relatively expensive and, therefore, cost prohibitive to small- and medium-sized U.S. firms and individuals. According to DOD officials, although DTIC is a good source for archival information, its uses are limited because the information is incomplete, not always up-to-date, and not specialized.

The Sources and Nature of Foreign Technology Information Used in Developing Federal Lists of Critical Technologies

Government and industry representatives involved in the development of federal lists of critical technologies said that, in general, the sources of foreign technology information that were used included (1) briefings from DOD, Commerce, and other federal government sources; (2) information provided by internal agency experts involved in research and development; (3) information provided by several private sector associations and institutes; and (4) discussions among themselves. In addition, they said the processes used to consider foreign technology information in preparing the lists of technologies for the National Critical Technologies Report, DOD's Critical Technologies Plan, and Commerce's Emerging Technologies Report were very informal and unstructured.

The National Critical Technologies Panel members told us that the knowledge gained from their own discussions of foreign technology information was very valuable in developing the list, but the foreign technology information available from the processes we reviewed was too general. According to DOD and Commerce officials, in-house agency experts were the main source of foreign technology information used in developing their agencies' lists, although this data was supplemented with information from intelligence sources. DOD and Commerce officials stated that the people involved in compiling their agencies' lists (1) are aware of what is going on in their area of specialty in U.S. industry and the rest of the world, (2) visit foreign laboratories, and (3) attend both international and domestic meetings on their area of specialty. These officials said that the nature of the foreign technology information used by DOD was primarily defense-related technological capabilities developed overseas while Commerce's information focused on future commercial applications of foreign technology.

The Views of U.S. Officials and Industry Representatives on How to Improve U.S. Efforts

Federal officials noted that a good deal of the information dissemination is currently restricted by (1) copyright requirements and obtaining copyright clearances are expensive and time consuming; (2) limited resources for translations of foreign, especially Japanese, materials; and (3) classified or proprietary nature of the information.

A Commerce official said that, although a federal clearinghouse specializing in foreign technology information may be useful, it is not clear whether it would be effective in providing both timely and critical information, and such a clearinghouse is not their first priority in terms of improving U.S. industrial competitiveness.

Although there was no agreement among the individuals we interviewed on how the processes we examined should be changed, several officials suggested that the U.S. government should (1) do market research on the needs of its customers; (2) encourage U.S. researchers to visit other countries more frequently to meet with foreign researchers, visit the laboratories, and attend conferences; (3) seek to ensure that such U.S. researchers are more thoroughly prepared before their visits to enhance the benefits to the United States; and (4) prepare a directory for policymakers, listing all leading experts that can be contacted regarding critical technologies and encourage the exchange of ideas among these experts. These officials also suggested that the U.S. government should examine successful models for collecting and disseminating foreign

technology information, including those of the private sector and foreign countries, such as Japan and Sweden.

Exchange of Researchers and Students Between the United States and Japan

Several government officials and private sector representatives that we interviewed said that overseas visits by researchers are one of the most effective means of obtaining information on the latest developments in science and technology in other countries. Our review of data from the Science and Technology Agency of Japan and the Institute for International Education, a U.S. private sector institute, indicated that there is a large disparity in the number of researchers and students exchanged between the United States and Japan. For instance, Japanese researchers that spent longer than one month in U.S. laboratories and universities in fiscal year 1989 outnumbered U.S. researchers in Japanese laboratories and universities more than 2 to 1. In addition, Japan paid the supporting costs for a far greater proportion and number of both U.S. and Japanese researchers than the United States. In 1988-89, there were more than 16 times as many Japanese students in U.S. universities than U.S. students in Japanese universities. (See app. II.)

Nature of Private Sector Efforts

According to the Chairman of the National Critical Technologies Panel, private sector efforts are more successful than government efforts in collecting and disseminating foreign technology information mainly because they are focused toward the needs of their clients. Companies and other private sector organizations provide a wide variety of services and information and use foreign data bases and journals to collect this information. (See app. III.) Company representatives we contacted said that personal interaction with other U.S. and foreign researchers working on various technologies is a valuable information dissemination mechanism. With the exception of services from the Southern Technology Applications Center, most of the services we identified were expensive for small- and medium-sized companies, limiting the clientele base to large corporations that can afford the service.

Scope and Methodology

In reviewing five federal processes for collecting and disseminating foreign technology information to U.S. policymakers and industry, we interviewed and obtained documents from officials at DIA and Commerce who are responsible for formal efforts to collect and disseminate foreign technology information. We also interviewed senior officials at DOD, Commerce, and the Office of Science and Technology Policy responsible

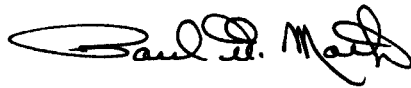
for developing the lists of critical technologies to obtain their views and reviewed records and documents related to the requested subject. In addition, we (1) interviewed various directors of private sector efforts and analyzed private sector documents describing companies' and organizations' processes for collecting and disseminating foreign technology information and (2) obtained from officials at the National Science Foundation data collected by the Science and Technology Agency of Japan and the Institute of International Education regarding the numbers of visiting researchers and students exchanged between the United States and Japan. We did not independently corroborate or verify the statistical data.

Our review was performed between February and August 1991 in accordance with generally accepted government auditing standards. As requested, we did not obtain agency comments on this report. However, we discussed our findings with program officials from DOD, Commerce, and the Office of Science and Technology Policy and have included their views where appropriate.

We are sending copies of the report to the Chairmen, Senate and House Committees on Armed Services and the House Committee on Science, Space, and Technology; the Secretaries of DOD and Commerce; and the Director of the Office of Science and Technology Policy. We will also make copies available to others upon request.

Please contact me at (202)275-8400 if you or your staff have any questions concerning this report. Major contributors to this report are listed in appendix IV.

Sincerely yours,



Paul F. Math
Director of Research, Development,
Acquisition, and Procurement Issues

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Abbreviations

DIA	Defense Intelligence Agency
DOD	Department of Defense
DTIC	Defense Technical Information Center
NIMS	National Industrial Security Program Information Management System
NIST	National Institute for Standards and Technology
NTIS	National Technical Information Service
SEMATECH	Semiconductor Manufacturing Technology
STAC	Southern Technology Applications Center

Processes to Collect and Disseminate Foreign Technology Information

According to U.S. officials and industry representatives that played a major role in developing the federal critical technologies lists, the foreign technology information collected by three of the five federal processes we examined was not directly used in developing the lists. The other two processes, Project SOCRATES and the National Industrial Security Program Information Management System (NIMS), were not in operation when the lists were developed. The policymakers and industry representatives that we interviewed said that they needed more current and specific data. This appendix provides more information about (1) the five federal processes to collect and disseminate foreign technology information, (2) the sources and nature of the foreign technology information that was used in developing the federal lists of critical technologies, and (3) the views of U.S. officials and industry representatives on how to improve federal collection and dissemination of foreign technology data.

Project Socrates

Project SOCRATES was a Defense Intelligence Agency (DIA) project that was in development and limited operation from 1984 to 1990. According to the former DIA official responsible for Project SOCRATES and DIA literature on the project, its mission was to provide a strategic level science and technology planning capability for U.S. military and economic competitiveness. To achieve this mission, Project SOCRATES was intended to track the technological capabilities of all technologically significant countries in terms of (1) years ahead or behind U.S. capabilities and (2) the parameters of the know-how, equipment, and materials that gives the country its state-of-the-art capability. In addition, the project was intended to provide foreign availability and capability information to assist the Department of Defense (DOD), Commerce, and State officials in deciding whether to grant export licenses to U.S. companies. As DOD reported to Congress in 1986,¹ the anticipated result of Project SOCRATES would be to enable officials to limit the flow of technology to potential adversaries while increasing the competitiveness of U.S. companies in the world marketplace.

DIA officials stated that Project SOCRATES' mission was to (1) provide information for export control purposes and (2) track technologies relating to equipment, materials, and know-how.

¹DOD Report to the 99th Congress: The Technology Security Program, 1986.

According to the former DIA official responsible for Project SOCRATES and DIA officials:

- Data collection sources for this program included over 1,000 worldwide commercial computer data bases, people from the intelligence community, technical experts from the DOD laboratories, data from U.S. companies, patents, and military personnel.
- Dissemination of Project SOCRATES' information was restricted to government agencies and organizations.

The former DIA official also stated that, on average, 80 percent to 90 percent of the classified data on foreign technology capability that was available from DIA, the Central Intelligence Agency, and the National Security Agency could, and in many cases was, retrieved from unclassified open sources.² According to DIA officials, although it often appears that a high percentage of classified data can be corroborated using unclassified open sources, this percentage varies considerably depending on the public's interest in the information being published. The officials said that open sources cannot be relied upon to replace classified sources of information.

DIA officials stated that the collection process involved in the Project SOCRATES information system was lengthy, time-consuming, and expensive. For example, they said that contracts and agreements with national laboratories for Project SOCRATES to collect foreign technology information were prohibitively expensive. According to these officials, the program evolved into a multimillion dollar project that was not cost-effective and, because of DOD budget constraints, Project SOCRATES was a prime target for elimination.

The former DIA official said that DIA funds for the program were insufficient to provide foreign technology information to all the policymakers that required information on strategic level science and technology planning, such as the Under Secretary for Defense (Acquisition) and the Office of Science and Technology Policy. The former DIA official also said that although Project SOCRATES resided in DIA, a substantial proportion of the project's funding and nonmonetary resources were provided by other

²A DOD official stated, however, that analyzed information from intelligence agencies should not be confused with raw data from unclassified sources. He added that DIA and the other agencies add value to the information by analyzing and drawing conclusions from this information. The official added that either the conclusions or merely the subject of the analysis, or both, may result in security classification of the information.

government agencies and organizations, such as the Office of the Deputy Under Secretary of Defense for Security Policies.

According to the former DIA official, he envisioned the program to be a strategic level science and technology planning system designed to provide analytical support on defense issues involving the performance of the U.S. industrial base. This idea later became part of a strategy advanced by the Under Secretary of Defense (Acquisition) in 1988 to combine Project SOCRATES with a prototype data base on the defense industrial base, the Defense Industrial Network, to address national and international issues affecting U.S. competitiveness. Support for Project SOCRATES waned and the program was canceled in July 1990 due to DOD budget cuts. However, according to sources involved with the project, it lost most of its support because high level executive branch officials felt that the project's reports were trying to promote an "industrial policy" that they did not endorse. In fact, according to DIA officials, a Project SOCRATES report on high definition television was not released by DIA because it had been labeled "industrial policy."

World Technologies Database

World Technologies Database was used by DIA as an interim data base after Project SOCRATES' funds were cut in 1990 to analyze and store the foreign technology information that it collected from various sources. As opposed to Project SOCRATES, which had extremely detailed technology information on specific components and parts, World Technologies Database was designed to store aggregated technology information. However, the data base was not fully developed and only included information on flat panel displays. In addition, the data base was classified and contained proprietary business data; therefore, dissemination of the information was limited to government policymakers and agencies with appropriate clearances.

According to DIA officials, the purpose of World Technologies Database was to effectively maintain a viable foreign technology/industry information system with the limited funds remaining after Project SOCRATES was cut from DIA's budget. The process was less expensive and time consuming than Project SOCRATES; however, in late 1991 DIA officials determined that such a data base was too limited and a more comprehensive program was needed.

NIMS

NIMS is DIA's newly initiated data analysis and information management system that is currently in the development stages. According to DIA officials, NIMS evolved from DIA's experience with Project SOCRATES and World Technologies Database. The National Industrial Security Program was mandated by President Bush in 1990 to increase efficiency and reduce costs associated with industrial security and encompasses the management of the Foreign Ownership, Control, or Influence³ and other industrial security programs.

According to DIA officials, NIMS is intended to support the National Industry Security Program by distributing information among agencies in the Foreign Ownership, Control, or Influence and the industrial security communities and enabling federal agencies to share data and reduce redundant technology collection efforts. A DIA draft report states that NIMS will (1) enable analysts and policymakers to take advantage of information collected by several agencies that support technology competitiveness activities and (2) allow each to examine the information needed to make assessments regarding foreign military technology competitiveness. According to DIA officials, NIMS' main focus is on (1) foreign technology acquisition and (2) trend analysis.

The National Technical Information Service

The National Technical Information Service (NTIS) is an information clearinghouse under the Department of Commerce's Technology Administration. Its basic function is to make available to its subscribers the results of research developments from its primary sources. These sources are U.S. government agencies, U.S. contractors, and foreign governments.⁴ According to an NTIS official, NTIS provides abstracts of publications and other government research results to its subscribers, but generally does not analyze the information, or house classified or proprietary data. In addition, since NTIS has no material that it distributes exclusively to U.S. government agencies, copyright clearance is obtained on all copyrighted items that NTIS collects.

³Foreign Ownership, Control, or Influence deals with restrictions that provide authority to deny access to classified information to a foreign owned or controlled facility. Agencies with Foreign Ownership, Control, or Influence responsibilities include: DOD components and the military departments, the Departments of Commerce, Treasury, State, Energy, the Central Intelligence Agency, the National Security Agency, and the Federal Emergency Management Agency. DOD is mandated to be the lead agency responsible for NIMS in Presidential Directive 10865.

⁴NTIS has contact and information-sharing agreements with counterpart services in other countries.

**Appendix I
Processes to Collect and Disseminate Foreign
Technology Information**

According to an NTIS official, while NTIS does not have restrictions on who subscribes to it,⁵ many of its users are large U.S. companies. The official also said that foreign governments and companies subscribe to NTIS. Although the official could not identify the number of overseas users, he did say that 24 percent of NTIS' sales income comes from foreign subscribers, mostly through agreements with 43 "cooperating organizations" in 38 countries, which further disseminate NTIS materials to their clients. In addition, the official said that these agreements permit foreign cooperating organizations to reproduce and sell NTIS materials that are not copyrighted, such as federal government reports, to other interested parties upon payment of a share of these sales to NTIS. According to an NTIS official, some countries, such as Japan, Germany, and Canada, do this extensively.

NTIS officials stated that, based upon recommendations from a White House "Domestic Policy Review" group tasked to identify federal programs that would enhance industrial innovation, President Carter requested in 1979 that Congress fund a \$2.4 million NTIS program to collect and translate foreign technology information of particular interest to U.S. industry. The program received approximately \$1.5 million for fiscal years 1981 through 1983.⁶ Although funding for the program was originally intended to continue through 1986, NTIS has not requested appropriations since fiscal year 1983 because of its decision to become completely self-supporting, operating on the income it receives for providing information and other services.

According to an NTIS official, this decision was based on the expectation that the U.S. market for foreign science and technology information would develop in subsequent years to an extent that appropriated funding would be unnecessary. The official said that the main reason that NTIS has difficulty being self-supporting is that this market has not developed to the extent expected. He added that, "In view of the slow development of the U.S. market for foreign science and technology products, the same decision would not be made today."

NTIS serves as the central source for federally generated computerized data files, data bases, and software and for information on the licensing of U.S.

⁵One exception is countries or organizations that are embargoed by U.S. trade regulations.

⁶NTIS' foreign technology collection and dissemination program received \$750,000 for fiscal year 1981, \$500,000 for fiscal year 1982, and \$252,000 in fiscal year 1983.

government-owned patents. NTIS also provides to subscribers listings and abstracts of the information it has available on specific technologies and names of contacts who have done analyses in specific technologies. Updates on overseas science and technology developments and summaries of technical reports of interest to U.S. industry are also available through its 27 categories of newsletters on such topics as business and economics, building industry technology, and manufacturing technology.

In addition to these services, NTIS has access to a series of Japanese data bases through the Japan Information Center of Science and Technology,⁷ a large Japanese technical library that receives 50 percent of its funds from the Japanese government and recovers the remaining portion of funds through the sale of products and services. The Japan Information Center provides unpublished Japanese government reports as well as information from commercially available journals, mostly in Japanese. NTIS subscribers can access this information through the Japan Information Center On-Line Information System. However, NTIS officials stated that many U.S. companies do not use the On-Line Information System because of translation difficulties, and many of the companies that do use the On-Line Information System are high technology companies that obtain this information through existing direct arrangements in Japan rather than through NTIS.

NTIS officials stated that the clearinghouse has several problems. For example, they said (1) as a self-supporting government entity, the revenues earned from NTIS' sales must pay for its operation; therefore, NTIS customers support the services they receive as well as overhead relating to additional tasks NTIS undertakes, such as research on machine-aided translation; (2) because NTIS is expensive to use, it is not reaching its potential U.S. market, which tends to limit the availability of this information to the larger companies that can afford it; (3) since many documents are only available in their original language, the shortage of qualified technical translators, especially Japanese-to-English translators, and the resultant higher cost of translating documents,⁸ limits the

⁷The Japan Information Center for Science and Technology's missions include (1) acquiring and preparing science and technology information for Japanese users and (2) disseminating the information. The work of selecting and translating the foreign technology information is carried out by approximately 4,000 Japanese scientists and engineers.

⁸An NTIS official stated that cost depends largely on the availability of translators and that it usually costs between \$6,000 and \$8,000 to have a 150-page Japanese language document translated into English.

information's availability and usefulness; and (4) public awareness of NTIS is limited.

Federal officials and industry representatives noted the following additional NTIS limitations:

- The information available through NTIS includes federal government reports, but only to the extent that agencies provide these reports to NTIS.
- The foreign technology information is usually copyrighted and requires copyright clearance, which is expensive and time consuming.
- The translation of foreign technology information, especially Japanese to English, is costly.

NTIS is evaluating computer-aided translation to alleviate translation problems. However, according to the NTIS Program Director and other NTIS officials, (1) improving NTIS' process of information collection and dissemination would require improving public awareness of its available services through better marketing strategies and (2) appropriated funds are needed to collect a wider range of information and broadly disseminate it. Otherwise, they believe NTIS will continue to be cost prohibitive to individuals and small- and medium-sized U.S. firms.

The Defense Technical Information Center

The Defense Technical Information Center (DTIC) is a clearinghouse that has the primary responsibility for collecting defense-related science and technology information, both domestic and foreign, and is DOD's central collection and distribution point for this information. According to the DTIC Administrator, defense-related science and technology information includes a wide range of technologies, many of which, such as integrated circuits and supercomputers, are also of interest to those outside the defense community. The foreign technology divisions of DOD's individual services and agencies are required to provide foreign technology information to DTIC, when dissemination and release restrictions permit. Other sources of DTIC's foreign technology information include the North Atlantic Treaty Organization's Defense Research Group, the Technical Cooperation Program,⁹ and bilateral information exchange agreements.

⁹The Technical Cooperation Program is a group of cooperating countries, including the United States, the United Kingdom, Canada, Australia, and New Zealand, that facilitates the exchange of technology information resulting from their cooperative activities.

DTIC provides both classified and unclassified information to the defense community and other federal agencies such as the Central Intelligence Agency, the Department of Energy, and the National Aeronautics and Space Administration. Unclassified DTIC reports authorized for public release are made available to the public through NTIS. DTIC is currently the largest federal contributor to NTIS.

DTIC also manages and funds 14 DOD Information Analysis Centers that collect scientific and technical information within specialized areas that are essential to DOD's mission, such as composite materials, ceramics, and high temperature materials. According to a DOD official, formerly a DTIC resources manager and technical analysis policy writer, the centers are aggressive in collecting defense-related foreign science and technology information from a wide variety of open sources and evaluate how well the United States is doing in a technology compared to its competitors. The DTIC Administrator stated that within certain limitations, such as contract terms and funding availability, these centers supplement DTIC services by providing DOD timely access to worldwide scientific and technical literature and data collections.

DOD officials said that DTIC is a good source for archival information; however, its uses are limited, because the information it provides is incomplete, focusing primarily on military interests. In addition, the officials stated that DTIC information is not always up-to-date, specific, or analyzed to satisfy a requester's individual needs. In fact, an official involved in developing the DOD Critical Technologies list said that when he needs the most current and analyzed foreign technology information, such as that required when developing the DOD list, he tasks either DIA or experts at the defense laboratories to obtain the information. According to the DTIC Administrator, these experts may use the Information Analysis Centers in developing a response. However, the DOD official noted that the Information Analysis Centers usually do not have the most up-to-date information that has not yet been published.

DTIC is funded in DOD's budget through fiscal year 1993 but currently is supplemented by funds from user fees.

The Sources and Nature of the Foreign Technology Information Used in Developing Federal Lists of Critical Technologies

The timely development and deployment of critical technologies is essential to satisfy such national needs as defense, economic competitiveness, and public health. In developing their separate lists of critical technologies, the National Critical Technologies Panel, DOD, and Commerce considered foreign technology information in order to accurately reflect the U.S. position on these critical technologies vis-a-vis its competitors. However, they did not directly use foreign technology information from three of the federal processes we examined. The other two processes, Project SOCRATES and NIMS, were not available when the lists were developed.

National Critical Technologies Panel's Report

The National Critical Technologies Panel was appointed by the Director, Office of Science and Technology Policy, Executive Office of the President. The panel released its first biennial report, required by the fiscal years 1990 and 1991 Defense Authorization Act, on March 22, 1991. The report described 22 technologies considered essential for U.S. long-term security and economic prosperity. The purpose of this report and future editions is to increase government and industry awareness of the crucial role of technology in achieving national goals.

According to members of the National Critical Technologies Panel, foreign technology information was considered when developing the list of critical technologies. They stated that such information was made available to them through (1) briefings provided by DOD, Commerce, and other federal government sources; (2) information provided by internal agency experts in research and development; (3) information provided by several private sector associations and institutes; and (4) discussions among panel members. The panel's chairman emphasized the usefulness of the inputs provided by private sector and government agency experts in helping the panel select and refine the 22 critical technologies. Panel members agreed that the aggregated foreign technology knowledge that came out of discussions among panel members was very valuable in developing the list.

According to panel members, the nature of the foreign technology information focused on military and economic perspectives relating to technological developments. They also said that the briefings supplied information on the U.S. technology position relative to its competitors and showed whether the United States was gaining or losing its competitive edge in various critical technologies. According to one panel member, the information in the briefings was useful in providing different perspectives, which reinforced the information's credibility and pointed out gaps. Panel

members stated that although the information was useful as background information, it was too general and should have been supplemented by detailed briefings from top experts on the categories of technologies under consideration. Another panel member stated that additional information from companies like SRI International (formerly Stanford Research Institute) would have been useful in preparing technology profiles, but at the time the member was not aware of the existence of this service.¹⁰

DOD Critical Technologies Plan

The 1991 DOD Critical Technologies Plan described 21 technologies considered essential for maintaining the qualitative superiority of U.S. weapon systems. This was the third list of DOD critical technologies, which has been developed annually as part of DOD's Critical Technologies Plan. DOD uses this list to plan investment strategies for future weapon systems and for research and development. According to the 1991 plan, the defense critical technologies were the leading edge of DOD's Science and Technology Program and represent those technologies that are likely to set the pace of innovation in the development of advanced weapon capabilities and the evolutionary modernization of today's systems.

DOD officials that were part of the working group that developed the 1991 list stated that foreign technology information was considered, but not explicitly addressed, when the list was developed. According to one working group member, the sources of foreign technology information were (1) the knowledge of the working group members and other internal agency experts and (2) DIA and Central Intelligence Agency studies on requested technology information.

According to DOD officials, the nature of foreign technology information provided to the working group was primarily defense-related technological capabilities being developed overseas. The information had been assessed by DOD experts from a military perspective and had been indirectly assessed from an economic perspective through DOD's access to Central Intelligence Agency information. A DOD working group member stated that the most valuable and current information was obtained through personal

¹⁰SRI International is a consulting company that provides business, engineering, policy, science, and research services for clients. The Business Intelligence Center at SRI International collects foreign technology information and disseminates this information to clients through monthly technology profiles, a newsletter that reports recent developments, and consultations. Technology profiles focus on the commercialization of a technology, briefly describe it, and provide an integrated technology and market perspective.

interaction. DOD officials said that the people involved in developing the lists are required to be aware of what is going on in U.S. industry and the rest of the world in their areas of specialty. The member stated that neither DTIC nor NTIS were directly used when the list was developed since the information that these services provide is limited and not analyzed. The member also stated that when confronted with a task like identifying critical technologies, senior government officials usually do not have time to individually analyze such information but depend on a network of experts.

Commerce's Emerging Technologies Report

The 1990 Emerging Technologies Report identified 12 emerging technologies with the potential to create a multitude of new products and services and to substantially advance the productivity and quality of American industries. This list is the second one that has been developed by the National Institute of Standards and Technology (NIST),¹¹ under Commerce's Technology Administration. It provides a source of information to be used by government, industry, labor, and academia as programs and policies are established to exploit new emerging technologies.

A NIST official that participated in developing this list stated that foreign technology information was informally considered. The official also said that this information was obtained through NIST staff, industry representatives and associations, and formal government programs, where available. The NIST staff also indirectly obtained information through informal interaction with intelligence personnel.

According to a NIST official that participated in the development of Commerce's list, the nature of the foreign technology information focused on future commercial applications of technology in other countries and was useful, even though the process by which it was collected was informal and unstructured. In addition, the official stated that because NIST staff members have a broad technology information base, they know the latest developments in each technology field that was considered and have good domestic and international contacts. The information they provided was considered sufficient in developing the list.

¹¹The National Institute for Standards and Technology is a center for science and engineering research. Its laboratories perform research across a broad spectrum of disciplines affecting virtually every industry. Primary fields of the National Institutes's research include chemical science and technology, physics, materials science and engineering, electronics and electrical engineering, manufacturing engineering, computer systems, building technology, fire safety, computing, and applied mathematics.

The Views of the Participating Federal Officials and Industry Representatives

Evaluating the usefulness of the foreign technology information that government agencies and other sources make available to policymakers and industry is difficult without first doing market research to identify the needs of the users of this information. When these needs are determined, they can be applied as criteria to evaluate how well the information has fulfilled the users' needs. The government officials and industry representatives that played a major role in developing the federal lists of key technologies had first-hand experience in assessing the practical worth and applicability of such information. These officials also had several suggestions for improving the process of collecting and disseminating foreign technology information.

Our discussions with federal officials and industry representatives included whether creating a federal clearinghouse that specializes in foreign technology information would improve the federal government's processes for collecting and disseminating foreign technology information. Commerce officials stated that, although such a federal clearinghouse may be useful, it is unclear whether it would effectively provide timely and critical information to policymakers and industry. He said that one area of concern that needs to be examined is whether the raw data a clearinghouse provides is useful or whether this data should be further analyzed.

Commerce officials told us that a federal clearinghouse specializing in foreign technology information is not their first priority in terms of improving U.S. industrial competitiveness. According to the officials, a priority for improving competitiveness is to change the weak U.S. industry structure regarding (1) the lack of cooperation among U.S. producers, suppliers, and users and (2) regulatory issues, such as intellectual property regulations and trade laws.

Commerce officials and members of the National Critical Technologies Panel stated that one way of improving this process is for the government to encourage U.S. researchers to visit other countries' laboratories and attend international conferences. Such exchanges are important since, as some of the government officials and private sector representatives emphasized, overseas visits by such researchers are one of the most

effective means of finding out the latest developments in science and technology in other countries.¹² In addition, officials said that a disparity exists in the numbers of such researchers and students exchanged between the United States and Japan. According to Commerce officials, financial incentives, such as federally funded fellowship programs and federal tax deductions for sponsoring U.S. corporations might encourage a reduction in this disparity. However, another Commerce official stated that, even with incentives, U.S. researchers may be reluctant to volunteer for long-term assignments (6 months or more) in Japan because of cultural differences and language barriers.

Other federal officials stated that another way to improve the process is to prepare U.S. researchers who go overseas. They also said that there should be an appropriate balance between providing and receiving technical information. A NIST official said that foreign researchers, especially the Japanese, are very well-prepared. Industry representatives agreed and said that, in most instances they observed, the Japanese researchers had thoroughly researched the issues for their overseas visits. These representatives also stated that the Japanese researchers were very focused on learning, whereas U.S. researchers had a greater tendency to provide information rather than obtain it. In addition, a National Critical Technologies Panel member said that the United States can learn a great deal from foreign researchers and that it is important for U.S. government officials and researchers to strike a balance between providing and receiving information. The member indicated that his government agency is currently making an attempt to strike such a balance.

Commerce's Under Secretary for Technology stated that another way of improving the process is to provide U.S. policymakers with a directory of technology experts with current and historical knowledge and to encourage contacts among these experts. The Under Secretary indicated that, as a policymaker, he would find such a directory very useful. A NIST official agreed that a comprehensive directory would be useful and stated that, currently, there are directories of experts within individual agencies and organizations, such as NIST, the Department of Energy Laboratories, the National Science Foundation, and the National Institutes for Health.

¹²According to federal officials, although the professional scientist is generally able to assess the importance of information and judge the quality of the research and the changes that he observes, sometimes the individuals who collect information on foreign science do not have the relevant background and thus have difficulty understanding the significance of the information.

According to the official, existing directories of experts are not comprehensive, and in some cases, are not frequently updated.

Other suggested opportunities to improve the process involve studying and analyzing the processes of other countries. The Chairman of the National Critical Technologies Panel stated that the U.S. government should consider the models of foreign technology information collection and dissemination in the private sector, as well as other countries' successful processes, specifically those of Japan and Sweden.¹³ The Chairman said that (1) the process of effectively collecting and disseminating technology information is a difficult task; (2) the U.S. government has not been very successful in its implementation; and (3) private sector efforts to collect information are more successful than government efforts, because they are entrepreneur-oriented and focus on information requested by their clients.

The Chairman also said that large U.S. and foreign corporations make extensive use of research and development and manufacturing facilities that they have established overseas to stay apprised of foreign technology developments. In addition, U.S. industry associations collect foreign technology information and disseminate it to their members, in effect, benefiting small- and medium-sized companies.

According to a March 1991 SRI International survey report, National Science Foundation officials believe that although there is a wealth of easily accessible scientific and technical information, their information needs center around information on science and technology policies and priorities of other countries, including trends in support of research, major areas of program development, public policy in relevant areas, and the research environment. According to the report, such needs arise out of a desire to know what the competition is currently doing and plans to do in the future to (1) validate U.S. plans and priorities and (2) ensure that the competition does not know something that the United States does not know.

¹³The Chairman, Subcommittee on Defense Industry and Technology, Senate Armed Services Committee, has recently requested that we determine how effectively U.S. military, civilian government, and private sector resources in Japan monitor foreign technology information and disseminate it to relevant policymakers and industry representatives compared to Japanese resources performing similar roles in the United States. We have recently initiated work on this request.

Disparity in the Number of Visiting Researchers and Students Exchanged Between the United States and Japan

Several government officials and private sector representatives that we interviewed said that overseas visits by researchers and students are one of the most effective means of obtaining information on the latest developments in science and technology in other countries. They also said that many countries are successful in obtaining information through such visits. Our review of available data indicates that there are many more Japanese researchers and students working and studying in the United States today than there are U.S. researchers and students working and studying in Japan. According to a National Science Foundation official, both U.S. and Japanese governments have recognized this disparity and are attempting to improve the balance through programs, such as the National Science Foundation's Japan Program, which sends U.S. graduate students to work in Japanese laboratories.

On the basis of the Japanese government data, more than 10,000 Japanese researchers visited U.S. federal laboratories or universities in fiscal year 1989 as compared to less than 2,000 U.S. researchers making such visits to Japanese federal laboratories or universities; this is a 5.3 to 1 ratio. (See table II.1.) Also, many more researchers from both countries visit universities rather than federal laboratories. Specifically, regarding long-term (1 month or longer) visits, available data indicates that Japanese researchers that spent time in U.S. laboratories and universities outnumbered U.S. researchers in Japanese laboratories and universities by a 2.4 to 1 ratio. (See table II.2.) According to a National Science Foundation official, Japanese researchers are often selected over American and other foreign researchers for positions in U.S. national laboratories.

Table II.1: Researchers Exchange for Fiscal Year 1989 (including both short- and long-term visits)

Exchange	Number In universities ^a	Number In federal labs ^b	Total
United States to Japan	1,847	119	1,966
Japan to United States	9,657	804	10,461
Ratio	5.2:1	6.8:1	5.3:1

^aThis is the number of exchanged researchers that are working in universities.

^bThis is the number of exchanged researchers that are working in federal laboratories, such as the National Institutes of Health, the National Science Foundation, and Department of Energy Laboratories.

Source: Science and Technology Agency of Japan.

**Appendix II
Disparity in the Number of Visiting
Researchers and Students Exchanged
Between the United States and Japan**

**Table II.2: Extended Researchers
Exchange for Fiscal Year 1989** (long-term,
1 month or longer, visits only)

Exchange	Number in universities^a	Number in federal labs^b	Total
United States to Japan	607	50	657
Japan to United States	1,457	117	1,574
Ratio	2.4:1	2.3:1	2.4:1

^aThis is the number of exchanged researchers that are working in universities.

^bThis is the number of exchanged researchers that are working in federal laboratories, such as the National Institutes of Health, the National Science Foundation, and Department of Energy Laboratories.

Source: Science and Technology Agency of Japan.

Available data indicates that the United States paid the supporting costs for 383, or 24 percent, of the Japanese researchers that spent 1 month or longer in the United States in fiscal year 1989, and for 86, or 13 percent, of the U.S. researchers that made long-term visits to Japan. Japan paid the supporting costs for a far greater proportion and number of such researchers. (See table II.3.) A National Science Foundation official stated that the Japanese government and private companies contribute funds to U.S. programs, such as the National Science Foundation's Japan Program.

**Appendix II
Disparity in the Number of Visiting
Researchers and Students Exchanged
Between the United States and Japan**

Table II.3: Researchers Exchange by Means of Supporting Costs for Fiscal Year 1989 (long-term, 1 month or longer, visits only)

	Number in universities	Number in federal labs	Total	Percent
United States to Japan cost borne by Japanese	476	43	519	79
United States to Japan cost borne by United States	79	7	86	13
United States to Japan cost borne by other ^a	52	0	52	8
Total	607	50	657	100
Japan to United States cost borne by Japanese	686	72	758	48
Japan to United States cost borne by United States	348	34	382	24
Japan to United States cost borne by other ^a	423	11	434	28
Total	1,457	117	1,574	100
Ratio	2.4:1	2.3:1	2.4:1	Not available

^a"Other" includes costs borne by the researcher or shared by the two governments.

Source: Science and Technology Agency of Japan.

According to data from the Institute of International Education, a private U.S. institute, in 1988 and 1989,¹ Japanese students in U.S. universities outnumbered U.S. students in Japanese universities by 16.3 to 1. (See table II.4.) About 30 percent of the 24,000 Japanese students are in either a technical field or in business/management. According to a National Academy of Sciences official, the business component is also important to U.S. competitiveness issues that are at the heart of U.S. and Japanese concerns regarding the disparity in the exchanges of researchers and students. (See table II.5.) Comparable data by field of study was not available for U.S. students studying in Japan.

¹The most recent data available on student exchanges was 1988 and 1989.

**Appendix II
Disparity in the Number of Visiting
Researchers and Students Exchanged
Between the United States and Japan**

**Table II.4: Student Exchanges for 1988
and 1989^a**

Number of U.S. students in Japan	1,475
Number of Japanese students in the United States	24,000
Ratio	16.3:1

^aThis data includes undergraduate and graduate students.

Source: Institute of International Education.

**Table II.5: Japanese Students in the
United States by Field of Study for 1988
and 1989**

Field of study	Number of students	Percent
Engineering/science ^a	2,856	11.9
Business/management	4,296	17.9
Social science	2,640	11.0
All others ^b	14,208	59.2
Total	24,000	100.0

^aThe "Engineering/Science" category includes physical and life sciences 3.0 percent, engineering 4.2 percent, math and computer science 4.1 percent, and agriculture 0.6 percent.

^bThe "all other" category includes: humanities, English, education, arts, health sciences, and undeclared.

Source: Institute of International Education.

Private Sector Efforts to Collect and Disseminate Foreign Technology Information

According to the Chairman of the National Critical Technologies Panel, private sector efforts are more successful than government efforts in collecting and disseminating foreign technology information mainly because they are focused toward the needs of their clients. Several companies and organizations were suggested to us by the government officials and industry representatives that we interviewed as examples of U.S. companies and organizations that successfully collect and disseminate foreign technology information. It should be noted that these companies and organizations provide a variety of services and information. This appendix provides information on the companies rather than comparing them.

The Microelectronics and Computer Technology Corporation and the Semiconductor Manufacturing Technology (SEMATECH) consortium are high technology research and development organizations that collect foreign technology information for specific projects and disseminate this information to member companies. On the other hand, the Southern Technology Applications Center (STAC) and SRI International collect and analyze foreign technology information for a wide range of clients. An SRI International representative told us that general foreign technology information that can be used by a variety of clients is less expensive to collect; however, clients are usually more interested in information that is focused and specific to their needs and, thus, more costly to provide since the clientele is limited. Technology Strategic Planning, Inc., uses the foreign technology information that it collects to assist in developing corporate strategic plans for its clients to become more competitive. Figure III.1 contains information on these private sector efforts to collect and disseminate foreign technology information.¹

¹These companies' operations are based on private funds except for SEMATECH, which receives one-half of its annual operating budget of \$200 million from DOD and the other half from member companies. Congress is currently deciding whether to reauthorize federal funding for SEMATECH. In addition, STAC is partially funded by the National Aeronautics and Space Administration, the Florida State University system, and the Florida state government.

**Appendix III
Private Sector Efforts to Collect and
Disseminate Foreign Technology Information**

Figure III.1: Private Sector Efforts to Collect and Disseminate Foreign Technology Information

Private Effort	Process	Information	Clients	Limitations
Microelectronics and Computer Technology Corporation	<ul style="list-style-type: none"> monitors foreign data bases and journals maintains relations with the Japanese government and corporate laboratories maintains membership in Japanese associations exchanges information with foreign scientists and researchers 	<ul style="list-style-type: none"> focused data collection analyses of information 	<ul style="list-style-type: none"> 22 shareholders and 49 associate members includes U.S. and Canadian firms 35 internal projects 	<ul style="list-style-type: none"> member companies do not readily share information in consortium
SEMATECH	<ul style="list-style-type: none"> monitors foreign data bases, journals, and newspapers scans information for value maintains ties with the international community shares information with member companies 	<ul style="list-style-type: none"> focused data collection analyses of information 	<ul style="list-style-type: none"> 14 member companies includes U.S. firms only 	<ul style="list-style-type: none"> difficult obtaining translated information in a timely manner difficult obtaining copyrighted materials travel abroad is expensive
STAC	<ul style="list-style-type: none"> monitors foreign data bases and journals discusses technologies with network of individuals and organizations analyzes information 	<ul style="list-style-type: none"> from abstracts to full analyses of information client counseling links clients with valuable people and resources 	<ul style="list-style-type: none"> 3/4 of its clients are small to medium sized companies few foreign companies U.S. government agencies, such as DIA and the Navy 	<ul style="list-style-type: none"> limited resources
SRI International	<ul style="list-style-type: none"> monitors foreign data bases and journals discusses technologies with experts attends relevant meetings 	<ul style="list-style-type: none"> analyses of information newsletters with recent developments expert advice 	<ul style="list-style-type: none"> 1/4 revenues from foreign governments and companies U.S. government agencies, such as the National Science Foundation 	<ul style="list-style-type: none"> lack of demand for information they provide marketing problem expensive for small- and medium-sized companies
Technology Strategic Planning, Inc.	<ul style="list-style-type: none"> identifies clients' business objectives uses open sources to identify technology information and linkages inputs this information into its own data base determines adversaries' technology strategies proposes technology strategy for client 	<ul style="list-style-type: none"> develops strategy for effective use of worldwide science and technology for a competitive advantage 	<ul style="list-style-type: none"> top 50 Fortune 500 companies no foreign companies no federal agencies 	<ul style="list-style-type: none"> expensive for small- and medium-sized companies

Note: This figure is intended to provide information on a variety of private sector efforts and not as a basis for a comparison of the companies.

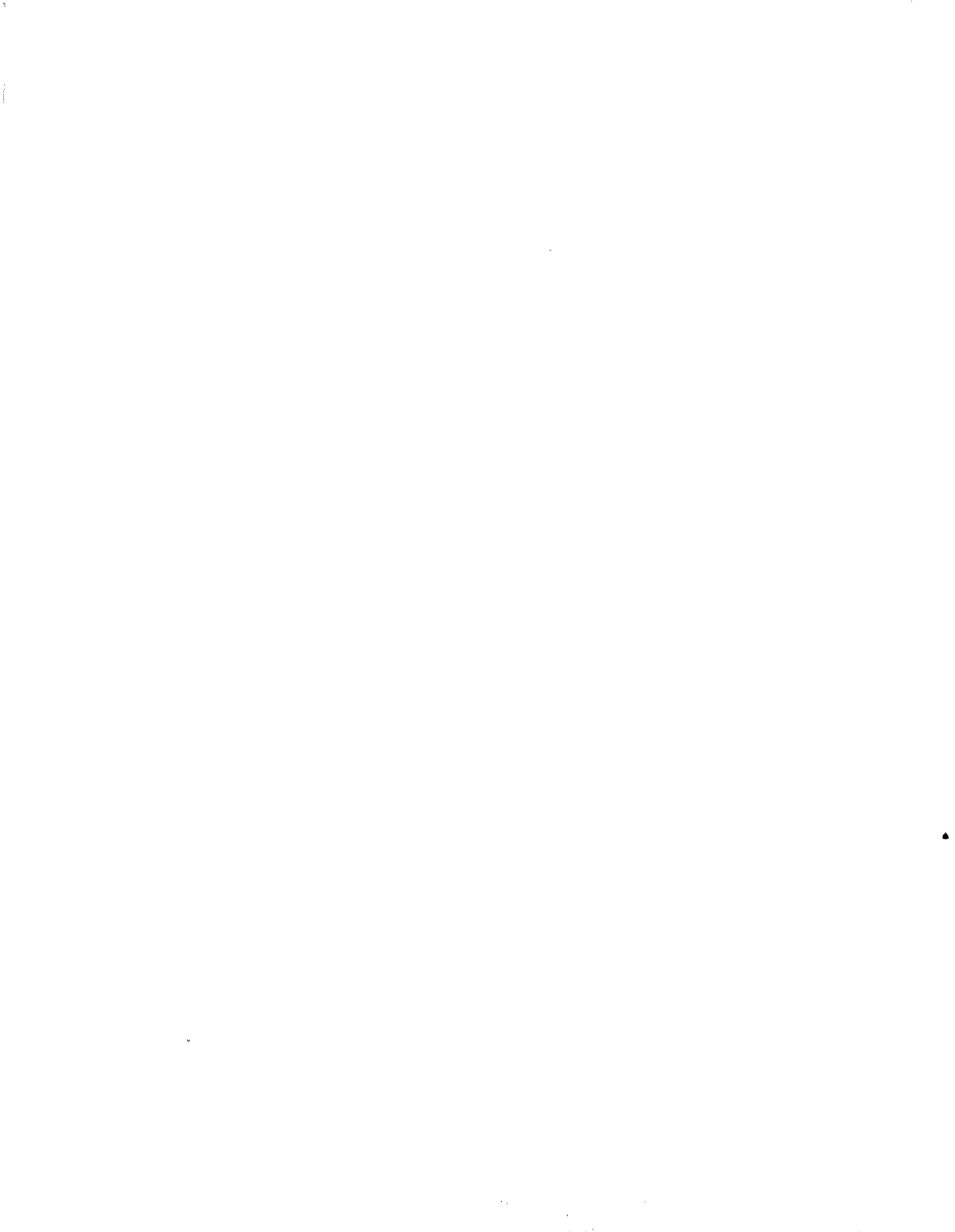
Other observations based on the information that we obtained from these companies' representatives are as follows:

- The companies provide a variety of services and information, ranging from abstracts and unprocessed data to client counseling and competitive strategies.
- All of the companies use foreign data bases and journals. However, SEMATECH representatives said that translating this information is difficult and expensive. The Microelectronics and Computer Technology Corporation has addressed this problem by having staff with extensive language skills in Japanese, French, and other languages. Copyright requirements also make the information difficult to obtain.
- Personal interaction with other U.S. and foreign researchers working on various technologies is considered a valuable technology information dissemination mechanism.
- Over 20 percent of SRI International's clients are foreign governments and firms.
- Most of these services are very expensive; therefore, the clientele base tends to be limited to large companies that can afford the service. One exception is STAC, which provides its services to small- and medium-sized firms. The funding that STAC receives from the National Aeronautics and Space Administration, the Florida state government, and the Florida State University system appears to contribute to the affordability of the service.
- Many of the organizations indicated the need for market research to identify the needs of clients and potential clients and said that such research is very expensive. An SRI International representative said there is a need to convey to company representatives the fact that foreign nations possess valuable technology information.

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