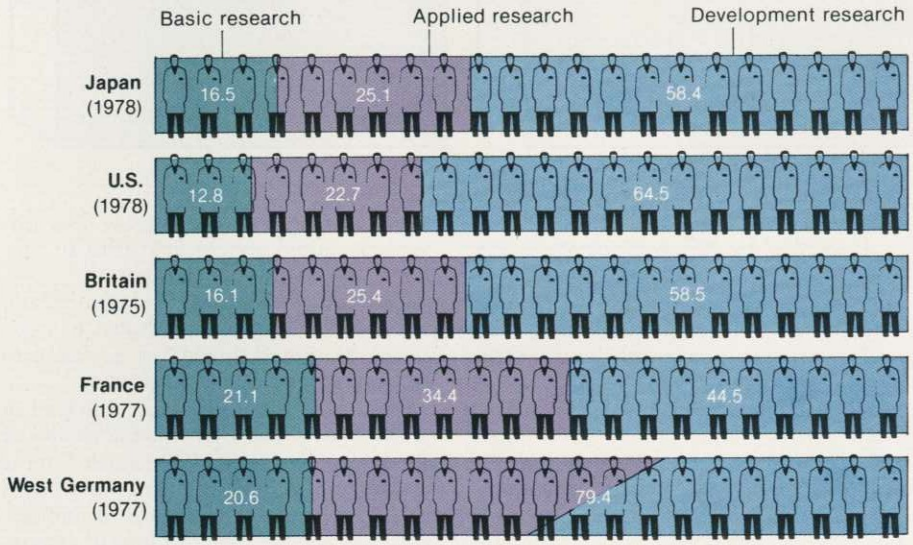
Table 1 Growth Rate of Japan's R&D Investment After the Oil Crises

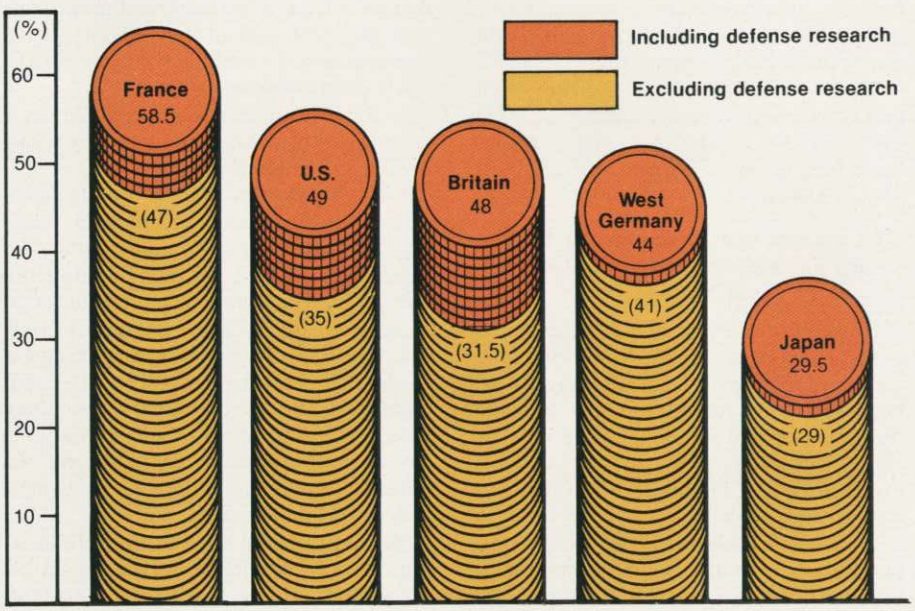
	1975~78	1978~81
GNP growth rate (nominal %)	10.9	7.1
R&D Expenditure growth rate (%)	10.8	13.9
Share, private sector funds	10.5	15.6
Share, government funds	11.9	9.7

Fig. 4 Composition of Research Spending by Major Countries (%)



(Note) West Germany does not distinguish between applied and development research.
(Sources) 1979 Report on Science and Technology Research and Development
Science and Technology Research in Fiscal 1981

Fig. 5 National Comparison of Government Share of Research Expenditure in 1979 (1978 for Britain)



efforts. For a long time it was said that Japan concentrated on applying imported technologies to develop processing technologies, but did little to develop its own advanced technology or to conduct high-risk basic research. However, Japan has now begun to make positive efforts in research in new fields, while continuing the quantitative expansion of technological development. Today, even with the pressing need for applied technologies to cope with the energy problem, Japan is still setting aside 15-20% of its total R&D budget for basic research. This compares favorably with the basic research expenditures of the U.S. and other advanced countries (Fig. 4).

Clearly, Japan's technological development—once criticized as highly dependent on foreign technologies—now matches that of the advanced Western nations both in quality and quantity. Japan will continue to step up its development efforts because they are essential for laying the foundations of an internationally oriented technology-based nation. This is Japan's foremost obligation to the world.

(2) Role of the Japanese Government

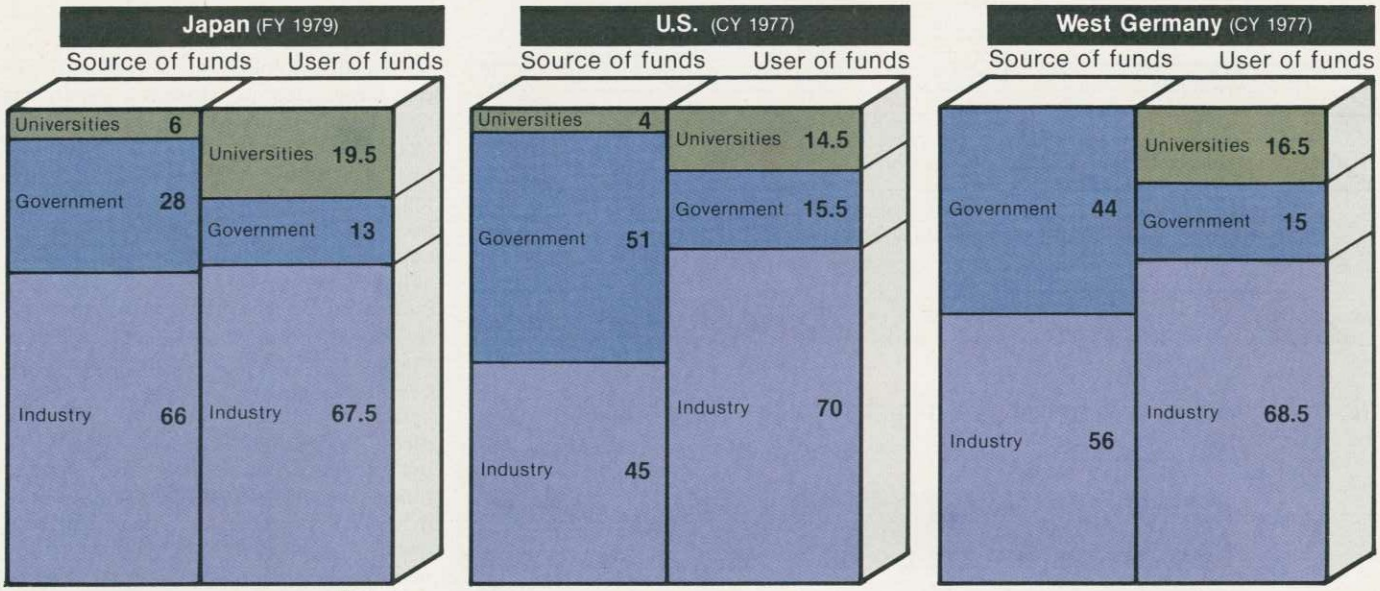
There have been charges that technological development in Japan is strongly supported by the government for the purpose of boosting Japanese industry's international competitiveness, and that this distorts fair competition in free trade. Certainly the government gave priority to fostering specific industries during the postwar recovery period in order to strengthen their international competitiveness. This was natural enough, given Japan's desire to reenter international society as quickly as possible.

However, nearly 40 years have passed since the end of World War II. Japan's technological development policy today is based on the principle of free competition in the private sector.

As the Japanese prime minister declared at the Versailles Summit in June last year, Japan should depend basically on the vitality of the private sector for scientific and technological development, though the government should play an important role in areas of technological development where risks for private industries are prohibitive because of long lead time and enormous investment. This is the basic principle of Japan's technological development policy.

We firmly believe that this principle is in line with the recommendations submitted to the governments of the advanced nations represented at the summit by the Working Group on Science and Technology. The recommendations read: "Governments have specific responsibilities which include the sponsorship of basic research, and research of far-reaching but uncertain applicability, whose social bene-

Fig. 6 Japan-U.S.-West Germany Comparison of Sources and Users of Research Funds (%)



(Notes) Industry includes private non-profit institutions. U.S. figures include research funds for humanities and social sciences.
(Sources) OECD "International Statistical Year Book 1977" Statistics Bureau of the Prime Minister's Office "Report on Survey of Scientific and Technological Research"

fits may not be matched by immediate commercial returns."

The government's share of R&D expenditures in Japan does not even come to 30%, making it much smaller than the approximately 50% in Western advanced countries. Excluding defense-related research spending does not significantly alter this balance (Fig. 5).

Japan's R&D expenditures in fiscal 1981 totaled $27 billion, of which the government's share was only $7.3 billion, or 27%. About 50% of the government's share (13.5% of total R&D expenditure) was allotted to basic research at universities, and 25% (6.5% of the total) to national science projects concerned with atomic energy, space and the ocean, to name but a few. Only some 15% (4% of the total), or slightly less than $1 billion, was allocated to industrial technology. Moreover, the bulk of this money went to research and development for energy-related technology or basic research. Consequently, at most, only 5% of the government's R&D outlay (1.5% of the total) goes for developing industrial technology. Recently, there have been calls both at home and overseas for the government to appropriate more for research and development that will benefit the next generation.

A comparison of who pays for and who uses R&D expenditures in Japan, the United States and West Germany shows even more clearly that the Japanese government's support of R&D is not as great as is believed (Fig. 6).

In fiscal 1979, 66% of Japan's R&D costs were borne by industry, 28% by government, and 6% by universities. Of Japan's total R&D expenditure, 67.5% was used by industry, 13% by the government and 19.5% by universities. Of the 28% supplied by the government, 13.5% went to universities, 13% was used by the government itself, and 1.5% by industry.

In the case of the United States, total R&D expenditures were distributed as follows: 70% industry, 15.5% government and 14.5% universities. In West Germany, it was 68.5% industry, 15% government and 16.5% universities. The breakdown is more or less the same in the three countries. But in the United States and West Germany, as mentioned earlier, the share of R&D costs borne by the government is larger, and that of industry smaller by comparison. Of government spending, the percentage used by industry is 25% in the U.S. and 12.5% in West Germany as compared with 1.5% in Japan. It is evident from this that American and West German industries benefit incomparably more than does Japanese industry from government R&D expenditure.

These facts, however, are not well known overseas. The breakdown of R&D expenditures is complex, but efforts should be made to inform foreign countries of the facts.

(3) Concepts and Directions for Becoming an Internationally Oriented Technology-Based Nation

By achieving sound and healthy development and contributing to international society, Japan is well along the road to becoming an internationally oriented technology-based nation respected by other countries. The basic concepts involved can be summarized into the following three points:

First, the development of technology, particularly high technology, helps broaden the economic frontier and revitalize the world economy. The advanced nations should link arms to promote this worthwhile endeavor.

Second, technological development and the transfer of its results should be open to all. Measures should not be taken to restrict technological interchange.

Third, in order to promote this kind of technological development, the vitality of the private sector should be utilized to the maximum, with government working to improve the environment for technological development while fulfilling its responsibilities under the first two points.

Japan is fully aware that technological development constitutes an investment for bequeathing assets to our descendants that can be shared by people all over the world. I believe we should constantly seek to accelerate the development of technology both from a medium- and long-range and an international perspective, while surmounting the various short-term difficulties that confront us.

In line with this basic concept, Japan is trying to implement concrete policy measures in the following ways:

First, Japan tries to promote the development of innovative technology by making the best use of its brainpower. This is essential if Japan is to make a contribution to international society. In order to develop creativity, it is essential not only for industry, universities and government to do their best in their respective capacities but also to coordinate and share their work. The Ministry of International Trade and Industry (MITI) and its research organs should play the central role in this undertaking.

Secondly, Japan should promote international cooperation in technological development. This is extremely important,

Photo: WWP

Summit leaders agreed to cooperate in promoting the development of science and technology in their meeting at the Palace of Versailles, Paris, in 1982.

not only for contributing successfully to international society but also for achieving the first measure. Technological development projects have grown in scale and now involve increasingly greater risks, raising problems on a global scale that cannot be dealt with by a single country acting alone. International cooperation is thus at once a global trend and a requirement of the times.

International Cooperation in High Technology

(1) Basic Thinking on International Cooperation in High Technology

Japan is vigorously promoting international cooperation in high technology in line with the principles explained above. I am confident that such cooperation will play an extremely important role in revitalizing the world economy, a goal eagerly sought by all countries. Such revitalization fundamentally means the development of a new frontier and the enlargement of the world economic pie. High technology can be one of the champions in this effort, and the expectations placed upon it are correspondingly great.

High technology by its very nature possesses the following two aspects:

First, its successful development requires venturing into hitherto untrodden fields. It is, therefore, indispensable that one be willing to accept the challenge posed by unforeseeable risks. Second, high technology has far-reaching effects on commerce and trade, industry, and society. As such, its development requires not only independent efforts by each country but also international cooperation in line with the concepts explained above.

From my personal experience in this field, I know fully well that international cooperation in science and technology cannot be promoted by ordinary efforts. At the same time, though, I think that Japan—which achieved its "miraculous" development after World War II with the material and psychological support of countries all over the world—should take the initiative in this effort and set an example for the rest of the world. Japan is now working to promote international high technology cooperation at the multilateral, bilateral, government-to-government and private sector levels.

Three recent examples of international cooperation are typical of such efforts. The first is the Working Group on Science and Technology formed in accordance with a Versailles Summit resolution, which is a representative example of multilateral government-to-government cooperation. The second is the Japan-U.S. High Technology Working Group, a case of bilateral government-to-government cooperation, and the third the Japan-EC Industrial Cooperation Symposium, an example of cooperation at the private level.

(2) Working Group on Science and Technology

This working group of top experts on science and technology from seven advanced countries and the EC was organized to promote the international cooperation in science and technology proposed at the Versailles Summit. The group met seven times between August 1982 and January 1983 to discuss ways of achieving this. As Japan's deputy representative, I myself made seven trips to Paris and other European cities.

Frankly speaking, it was hard for me to find time in my crowded work schedule to make these seven trips in six months. However, their value far outweighed the trouble.

First, I learned that the other advanced countries are all making much greater efforts than we had imagined to promote science and technology at the national level, and that they are doing so as an integral part of a comprehensive policy package.

Second, I felt keenly that Japan is still a remote country as far as the U.S. and Europe are concerned, and that they have less understanding of our R&D efforts than we had expected. I also learned that there exist quite a few misconceptions in the West about Japan's endeavors in science and technology.

Third, more than once I saw sparks fly from clashes between collaboration and competition—two sides of the same coin in international cooperation—and realized anew the enormous significance science and technology have in today's international society.

Fourth, I felt forcefully that our responsibility for making Japan into an internationally oriented technology-based nation is heavy indeed.

After more than 150 hours of intensive study and discussion, the Working Group compiled a report at the end of January and submitted it to the respective heads of government. The important points agreed upon by the Working Group and stressed in its report can be summarized as: (1) the need to use science and technology to revitalize the global economy and increase employment, (2) the importance of private sector vitality and government policy in promoting science and technology, (3) the need for international cooperation in science and technology and promotion of international cooperation projects, and (4) the need to place science and technology problems on the agenda of future summit meetings.

Another point which merits special mention is the fact that the Working Group concerned itself not only with general analysis and discussion but also undertook a practical study of concrete projects which would benefit from the cooperation of the advanced countries. Japan was assigned the leading role in some of these, particularly those related to advanced robotics, photovoltaic solar energy and photo synthesis. At the same time, Japan expressed positive interest in cooperating in more than a dozen other projects.

Heated debate flared up more than once during our seven meetings. At times, I seriously worried that the group might never reach agreement on the substance of the report and might itself break up. The final results, however, repesent a practical

step forward toward implementation of the basic concept I outlined earlier, and I personally am confident the report is one we can proudly present to the world and to future generations.

I also learned through the discussions in the Working Group that people the world over engaged in science and technology, be they researchers or administrators, have not lost their eagerness to join hands in developing a new frontier. And above all, I was deeply impressed to find that the Working Group was a gathering of people who take a back seat to no one in their ardor to bring peace and progress to the world. In my more than three decades of experience as a researcher and administrator, I have never been more strongly impressed. I am now more firmly convinced than ever that Japan's only path to survival lies in becoming an internationally oriented technology-based nation.

(3) Japan-U.S. High Technology Working Group

In science and technology, it is important to couple multilateral cooperation with bilateral cooperation. Especially given the many serious trade problems concerning ICs and computers which complicate high technology industry, it is vital that the two countries most advanced in the field cooperate in maintaining and expanding free trade and technological development. This cooperation is vital not only for Japan and the United States, but for the entire world.

In this spirit, the Japan-U.S. High Technology Working Group has energetically discussed technological cooperation, and in October last year submitted a set of recommendations to the governments of both countries.

The main purport of the recommendations was that, while competing freely in high technology fields, Japan and the U.S. should also seek to strengthen mutual cooperation where called for.

The recommendations were based on a common awareness that high technology industry can expand economic frontiers, revitalize the world economy, and improve the quality of man's life, and that "the government has a significant role to play in providing a favorable environment to facilitate private sector investment and research activities in the field of high technology." The recommendations specifically called for: (1) exchange of information on the development of technology, (2) maintenance of free trade, and (3) establishment of forums for discussions to be participated in also by the private sector.

In order to facilitate the first of these, the working group proposed establishing a channel between the two governments for exchanging information on R&D as well as promoting international cooperation in information exchange.

For the maintenance of free trade, the recommendations proposed that both countries guarantee each other maximum market access and, should there be obstacles impeding trade and investment, that their governments try to eliminate or reduce them.

Finally, the group proposed the establishment of a common data bank or task force to encourage greater discussion of the issues.

The governments of Japan and the United States decided in February this year to officially adopt the recommendations submitted by the Working Group. Vigorous concrete action is now needed to make them a reality.

Japan has decided to implement the recommendations beginning with the semiconductor field. I believe this will prove extremely important for Japan's evolution as an internationally oriented technology-based nation.

(4) Japan-EC Industrial Cooperation

Japan is stepping up cooperation with Europe in high technology and other fields in the name of industrial cooperation. In January this year, a Japan-EC symposium was held in Brussels, in which I participated as a panelist. All the panelists aired candid views regarding technology-related policy measures being pursued by Japan and the EC countries. The symposium was an extremely valuable opportunity for me, because it gave me a chance to explain Japan's efforts to develop technology while at the same time learning about the efforts being made by European countries. I appreciated the frank opinions expressed by EC representatives.

The scope of industrial cooperation is very wide. Cooperation in high technology fields—particularly computers, industrial robots and biochemistry—was actively discussed.

In the case of Japan and the United States, private corporations actively exchange information without government guidance. In the case of Japan and the EC, however, this does not always go smoothly. Consequently, MITI and the ministries of industry of Britain, France and Belgium hold regular consultations through which they try indirectly to stimulate the vitality of private industry and help firms to enter into joint ventures or exchange technical know-how. This, too, is another important task for Japan in becoming an internationally oriented technology-based nation.

(5) Toward an Internationally Oriented Technology-Based Nation

The above are three representative examples of international cooperation in high technology. In other areas, too, cooperative activities are being carried out with a view to materializing the basic concept of facilitating high technology development and sharing it with the world. The cooperation takes various forms depending on the partner country and the specific matter under consideration. In order to make international cooperation in high technology really effective, however, attention to details and diversified yet complementary approaches are necessary. Japan will spare no effort to encourage detailed, diversified cooperation for building itself up as an internationally oriented technology-based nation.

In conclusion, I would like to quote from a Newsweek article titled "Japan's High-Tech Challenge" which appeared in the August 9, 1982, issue:

"Ultimately, Japan's high-tech challenge to the West is a healthy one. It has already forced American and European firms to rethink their strategies and compete more effectively in the global market... Most important, however, Japan can make a giant contribution to the store of human knowledge as its engineers and scientists concentrate on homegrown innovation and turn away from the copycat past. That process has already begun."

We in Japan must always bear in mind that last remark about Japan's copycat past. At the same time, we must take special note of the statement, "That process has already begun." It is encouraging to know that our efforts have begun to attract attention abroad. Our most important task now is to follow through on this "process that has already begun," and realize Japan's goal of becoming an internationally oriented technology-based nation. ●

Seiichi Ishizaka is a former director-general of the Agency of Industrial Science and Technology of the Ministry of International Trade and Industry. A graduate of the School of Engineering of the University of Tokyo, Ishizaka joined MITI in 1947 and was assigned to the Japanese Embassy in Washington 1958-62 as a science attaché. He served as director of MITI's National Chemical Laboratory for Industry until his promotion to director general of the Industrial Science and Technology Agency in 1978, staying in the post until last March. He also served as the deputy Japanese delegate to the Versailles summit's Working Group on Technology, Growth and Employment. Ishizaka, 60, has a doctor's degree in engineering.