Research and Development in Japan—Present and Future

By Dr. Iizuka Kozo

The historical background of R&D in Japan

As the background of Japan's present state of R&D, the history of science and technology in this country should not be ignored. Strong public interest in the education of children and prevailing curiosity about western technology, cultivated throughout the modern age (Edo era), resulted in the explosion of technological development after the Meiji Restoration in 1868, which brought out the rapid modernization of this country. Unfortunately, the military use of advanced technologies in those days was of prime importance to governmental policy until the end of World War II. Even under such circumstances, there were some outstanding achievements made by Japanese scientists, four of whom were awarded the Nobel Prize for physics or chemistry after World War II. More evident achievements of Japan's science and technology was the well–known miraculous growth of her industry and economy during the 40–year period up to the 1980s.

Key factors in successful development were often ascribed to pertinent governmental policy and a few fortunate issues around this country, not the least of which was the role of a well–educated, high quality work force that should be fully considered. There is another important factor which is often overlooked; that is, an effective conversion of military technology to civil use.

In fact, the engineers who supported the military force during the war carried over the potential for technological development after the war. Now the scientists and engineers of the second generation who followed the war–end pioneers are nearing retirement and the future of Japan's science and technology rests on the shoulders of the third and fourth generations. At the same time, it has been widely recognized in this country that the condition of facilities for them must be drastically improved if they are to be expected to compete continuously with those in other industrialized countries.

Following is an overview of the present state of R&D in Japan, and recent steps taken by the government to solve the problems for the future are described.

Science and technology policy and administrative bodies

Japan's science and technology policy as a whole is formally decided by the Prime Minister's Council for Science and Technology, chaired by the Prime Minister and consisting of the members shown in Table 1. In reality, the draft policy to be approved by the Council is, as a rule, prepared by the Science and Technology Policy Committee placed under the Council, and its sub–committees consisting of specialists in various sectors. The Policy Committee meets twice a month and shares its secretariat with the Science and Technology Agency (STA) and Ministry of Education, Science and Culture (MOESC), whereas the sub–committees are operated on an ad–hoc basis.

For implementing the policy, R&D programs are planned and administered by the offices in charge of respective ministries. For example, the Agency of Industrial Science and Technology (AIST) is playing such a role in the Ministry of International Trade and Industry (MITI) guided by the Industrial Technology Council. On the other hand, MOESC formalizes its administration on science through its Science Council. Nearly all ministries and agencies are more or less concerned with science and technology and operating some R&D activities by themselves in line with the general policies adopted by the Science and Technology Council.

Table 1
Members of Prime Minister's Council for Science and Technology

- Prime Minister
- Minister of Finance
- Minister of Education, Science and Culture
- Minister of State for Economic Planning
- Minister of State for Science and Technology
- President of the Science Council of Japan
- Two full–time and three part–time members from academia and industry (nominated by Prime Minister)

(Ministers of International Trade and Industry, of Agriculture, Forestry and Fisheries and of Posts and Telecommunications are invited as ad–hoc members.)

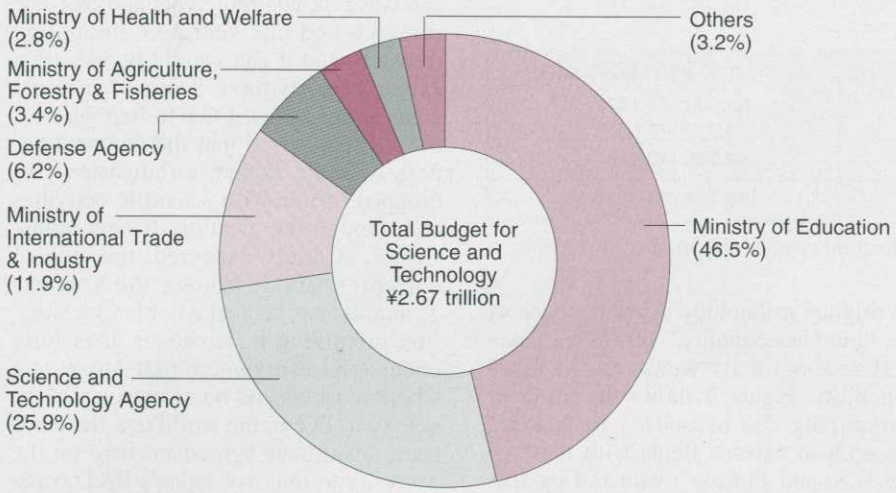
The status quo of Japan's R&D

Investments in R&D

According to the interim report by the Statistics Bureau of Japan, the total R&D expenditure of the country in 1994 decreased to ¥13.6 trillion, or 2.84% of GNP. The yen amount has fallen since 1993, while the percentage of GNP has grown smaller since 1991, although the percentage is still higher than those of most industrialized countries. Expenditure in the private sector (¥10.7 trillion) declined by 0.8% from the previous year, while that from the public sector (¥2.9 trillion) decreased by 1.6%. It has been pointed out repeatedly that the share of government expenditure in total is around 20% and is much less than the 32–46% of the UK, the U.S., Germany and France. It is also said that the ratio to GNP (0.60%) in Japan should be compared with 0.67%, 0.91%, 0.95%, and 1.10% in those countries respectively. Figure 1 shows the FY1996 budget for science and technology allocated to various ministries and agencies.

If the total expenditure above is classified according to the category of research, about 14.5% is for basic research, 25.6% for applied research and the rest (60.9%) for development. The issue of whether to increase the propor-

Figure 1. FY1996 Budget for Science and Technology by Agency



Source: White Paper on Science and Technology for 1996 (Science and Technology Agency)

tion for basic research, which is about 16% in the U.S. and 19% in Germany, is still pending. The Japanese government allocated ¥2.67 trillion for science and technology in its FY1996 budget (a 0.69% increase over the previous fiscal year), in which a new budget for basic research is to be applied for by researchers in open competition. This is prepared by six ministries (agencies) to the amount of about ¥32 billion, which shows the governmental policy to reinforce the R&D capability of the country in the area of basic research.

Human resources

One of the key components for R&D activity is human resources. The number of natural science researchers in Japan in 1995 was about 570,000, which is assumed to be a little more than half of the U.S. and a little more than twice Germany. Here "researchers" mean people who hold university degrees or the equivalent, with two or more years of research experience, and who perform research activities in their own specific area of study. The proportion of researchers to the population in Japan was 0.53% in 1995, relatively high compared with 0.37% in the U.S. (1993) and 0.30% in Germany (1991).

A distinct feature of the statistical data of Japanese researchers is that a notably high proportion of graduates are from engineering courses (61.7%), but it should be noted that the curriculums in many engineering courses in Japanese universities involve much more scientific subjects than those other countries and many departments in engineering faculties in Japan may be equivalent to scientific courses in other countries.

One of the problems in human resources in Japan is post–graduate students and post–doctoral researchers. The current capacity for doctorate students is about 15,000 a year, but actual enrollment is less than 12,000 (see Table 3). Both the capacity for and enrollment of doctoral students must be increased to fulfill future needs. This can be partly accomplished by improving graduate schools and by expanding student support. Post–doctoral researchers are expected to play an important role in creative studies in universities and laboratories, but the positions and support capacity provided for them are insufficient. The government is prepared to increase the number of programs, from about 3,800 in FY1995, to 5,900 in FY1996 and to 10,000 by FY2000.

Another problem is the lack of assistants and technicians in universities and research institutes. The average number of assistants per researcher was only 0.32 in 1995, which is less than half to one–third that of other industrialized countries.

Organizations for R&D

Organizations undertaking R&D in Japan are classified into six categories, shown in Table 2, where proportions of used expenditures and of employed researchers in each sector are presented. Figures are taken from the White Paper on Science & Technology for FY1995.

There are 81 national research institutes belonging to different ministries, with about 9,500 researchers and an allocated budget of ¥261 billion in FY1996, excluding defense research. The regional research institutes in the table are laboratories operated by local governments and number 656 with about 13,700 researchers and ¥284 billion in funds in 1994. Nowadays, many local governments are keen to establish so–called science parks or research parks by uniting their smaller research institutes into technology centers and utilizing them as a core of the industrial R&D consortium.

Table 2
R&D Organizations and Their Budget Share in 1995
Source: Science and Technology Agency White Paper for 1996

Sectors	Share in percentage	
	Expenditures	Researchers
National research institutes	3.1	1.8
Regional research institutes	2.3	2.4
Research institutes under special corporation	4.4	0.7
Private (non–profit) research institutes	4.6	2.4
Universities (national, public and private)	13.6	27.2
Industries	72.0	65.4

Table 3
Universities in Japan, 1994
Source: Science Council Report, 1995

	Total number	Number of graduate students
National universities	98 (71)	88,388 (27,187)
Public universities	48 (17)	5,795 (2,000)
Private universities	406 (169)	44,569 (10,116)
Total	552 (257)	138,752 (39,303)

Numbers in ( ) denote number of universities with doctoral courses and number of students enrolled in doctoral courses.

Research institutes under special corporations are usually funded by governmental ministries or agencies. Examples are the Japan Atomic Energy Research Institute and The Institute of Physical and Chemical Research (RIKEN), funded by STA.

Research institutes under non–profit foundations are often partly supported by the national or local government. The Research Institute of Innovative Technology for the Earth (RITE) is funded by MITI while the Bio–Oriented Technology Research Advancement Institution is supported by the Ministry of Agriculture, Forestry and Fisheries.

Universities in Japan are summarized in Table 3. They support about 14% of total R&D expenditure in Japan.

As a matter of course, both the amount of expenditure and the number of researchers in industry are dominant among the sectors in Table 2.

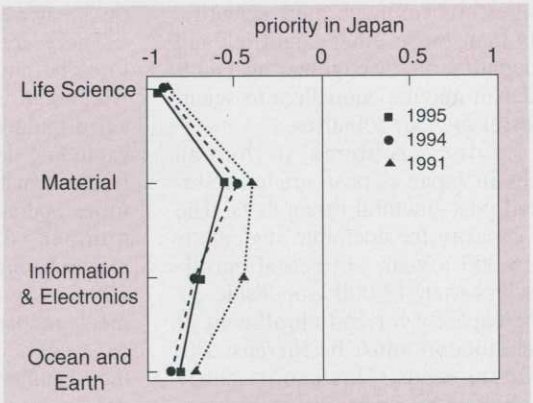
Problems in Japan's R&D and countermeasures for the future

In the 1980s, the Japanese government took a policy to reinforce basic research in order to develop original technology. After the burst of the "bubble economy," however, Japan realized again its weakness in R&D capability. Figure 2 shows the result of comparing the priorities in Japan's research in various fields with those of the U.S. and Europe, evaluated by specialists in respective fields. The comparison was repeated four years ago on basic research and one year ago on applied research, and it can clearly be seen that Japan's levels have dropped in most areas during the past two to four years. It is well recognized that the competitiveness of some Japanese industries also dropped in line with scientific activities and, though the creation of new industries is strongly expected, the lack of entrepreneurship among the younger generation has created a bottleneck situation in solving it. However, it is fully understood everywhere that Japan as a whole must depend on science and technology to live in the world and there has been unanimous agreement here on the necessity to improve Japan's R&D capa-

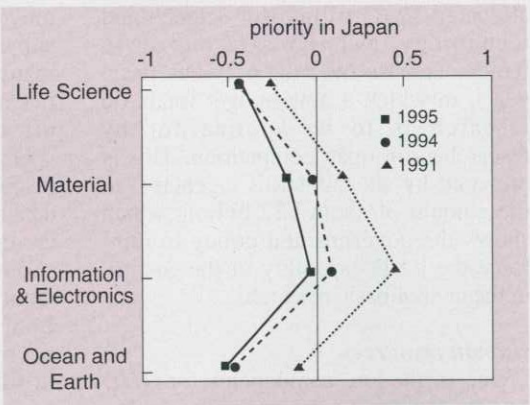
Figure 2 Comparison of research activity levels
Source: Report on the survey of R&D 1995 (Science and Technology Agency)

Basic Research

Comparison between Japan and U.S.

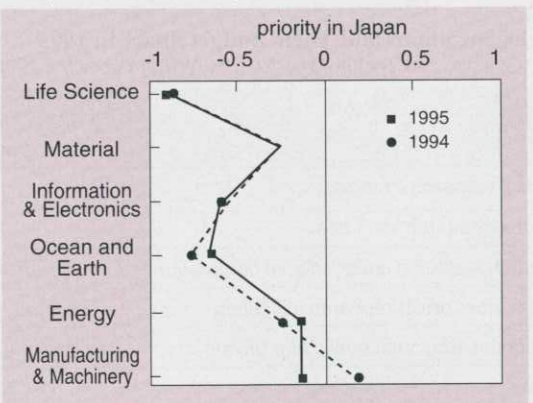


Comparison between Japan and Europe

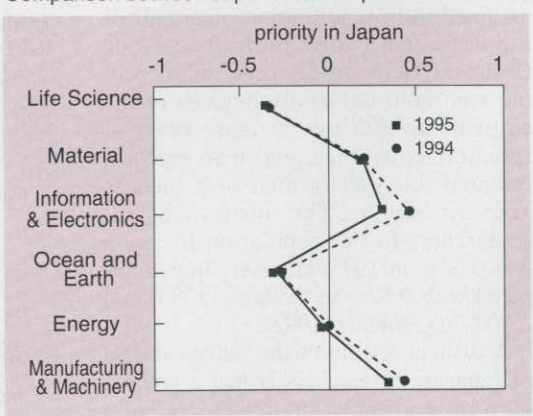


Applied Research

Comparison between Japan and U.S.



Comparison between Japan and Europe



bility. The problems in Japan's R&D system have been thoroughly investigated throughout the recent discussions for drawing up the basic plan for science and technology, and are mentioned below.

(1) Government funding for R&D has been insufficient in improving facilities in universities and research institutes and promoting creative studies, especially in graduate schools.

(2) Activity of younger researchers has not been fully induced because of various regulatory limitations, which hinder the emergence of entrepreneurs. There are also many regulatory barriers, which spoil flexible and efficient performance of researchers.

(3) Infrastructure for advanced R&D, that is, data bases, information networks, reference materials and standards etc. are far from the required level.

(4) Public understanding and recognition of the role of science and technology is rather poor and science literacy is lacking.

To intensify Japan's R&D by solving the problems stated above, the Science and Technology Basic Law was proposed by parliament members and finally enacted in November 1995. In accordance with the provisions of the law, the Science and Technology Council formulated the basic plan for science and technology as its 23rd Recommendation to the Prime Minister, which was approved by the Cabinet on July 2, 1996.

The plan aims at (1) the promotion of R&D for expanding frontiers for industry and for solving global issues and problems concerning people's lives and (2) the enhancement of basic research. It directs necessary actions to be taken by the government in the coming five years on the following items (main points):

(1) To realize an open and competitive environment for basic research.

(2) To increase human resources and to reform regulations for motivating researchers.

(3) To establish a fair and open evaluation system for R&D.

(4) To improve R&D facilities and infrastructure including high quality information networks.

(5) To enlighten the public to the understanding of science.

And, (6) to increase the government budget for science and technology for five years to 2000 to the total amount of about ¥17 trillion, a 12% increase per annum as an average.

Although there is some reluctance in the financial sector on the realization of the above increase, not only academia but also industry is welcoming the new basic plan outlined above as an epoch–making decision by the government and is looking forward to seeing the real implementation of each item indicated in it. JJTI

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[continued from page 19]

Japanese salesmen etc., though it is difficult to recruit these qualified personnel. Most of the highly qualified people are working with big companies because they have lifetime employment, a safe salary and high prestige. People who respond to newspaper ads are not always top class. In the Japanese system you are not always raised through your own achievements but by seniority.

Maybe the Japanese company offers assistance and personnel. This can sometimes be dangerous. Sometimes they offer people who are not of the highest caliber. The second point is that these people often are rented from the Japanese firm. That means that they are still on the payroll of the Japanese company. So they are safe, because if they are fired, they can just go back. So they can only be motivated with difficulty. There is only one solution: The people have to terminate their relationship with their old employer. If they do, they are motivated and real entrepreneurs. If not, they are useless.

So the successful start on the Japanese market needs three items: a good product, sufficient funds and motivated people.

The next problem is to become an insider. Japanese society is very tightly knit, related to each other (remember the keiretsu) and so homogeneous that basically—you cannot generalize too much—outsiders are outsiders. In Japan there is a word for that: Being inside the house and being outside of the house. People are treated differently according to that. In the house it is very cozy, a nice relationship, good business. Outsiders have to fight to come in. An outsider could enter the market with a better and cheaper product, but they will not buy, because he is not a part of the group. The insiders might loose some money, but they do not lose their relationship. And a good relationship rates above success. Entering the house is very difficult. It can take years of hard work. When all the connections are there and in the right place and everyone knows exactly about the product, and the producer is committed to the market and when they believe you are committed and will stay in Japan for a reasonable amount of time, then they will start doing business with you. Then the outsider enters the house, and he becomes an insider.

Then there is the need for a long range business plan. Big Japanese companies make plans for the next 20 or 30 years. There is no need to plan in these dimensions; it is enough to plan for the next five years. And there should be one highest aim to really be successful in Japan: do it on your own.

If the presuppositions are right and will be right in five years, if your company is fully embodied in the Japanese market, which means to be a member of various business circles and associations and having a position where people ask for your advice or give lectures or introductions from people who would like to work with you, then there will be success and the time is right to try business in Japan. JJTI

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