Japanese Technology

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Mr. Masanori Moritani, born in 1935, joined the Nomura Research Institute in 1967 after serving as an engineer at the Hitachi Works and later as an assistant at the Department of Technology of the University of Tokyo, from which he graduated in 1960. He is the author of Japan, China and Korea; Comparative Industrial Technologies (1980 Tokyo) and Japanese Technology (1982 Tokyo).

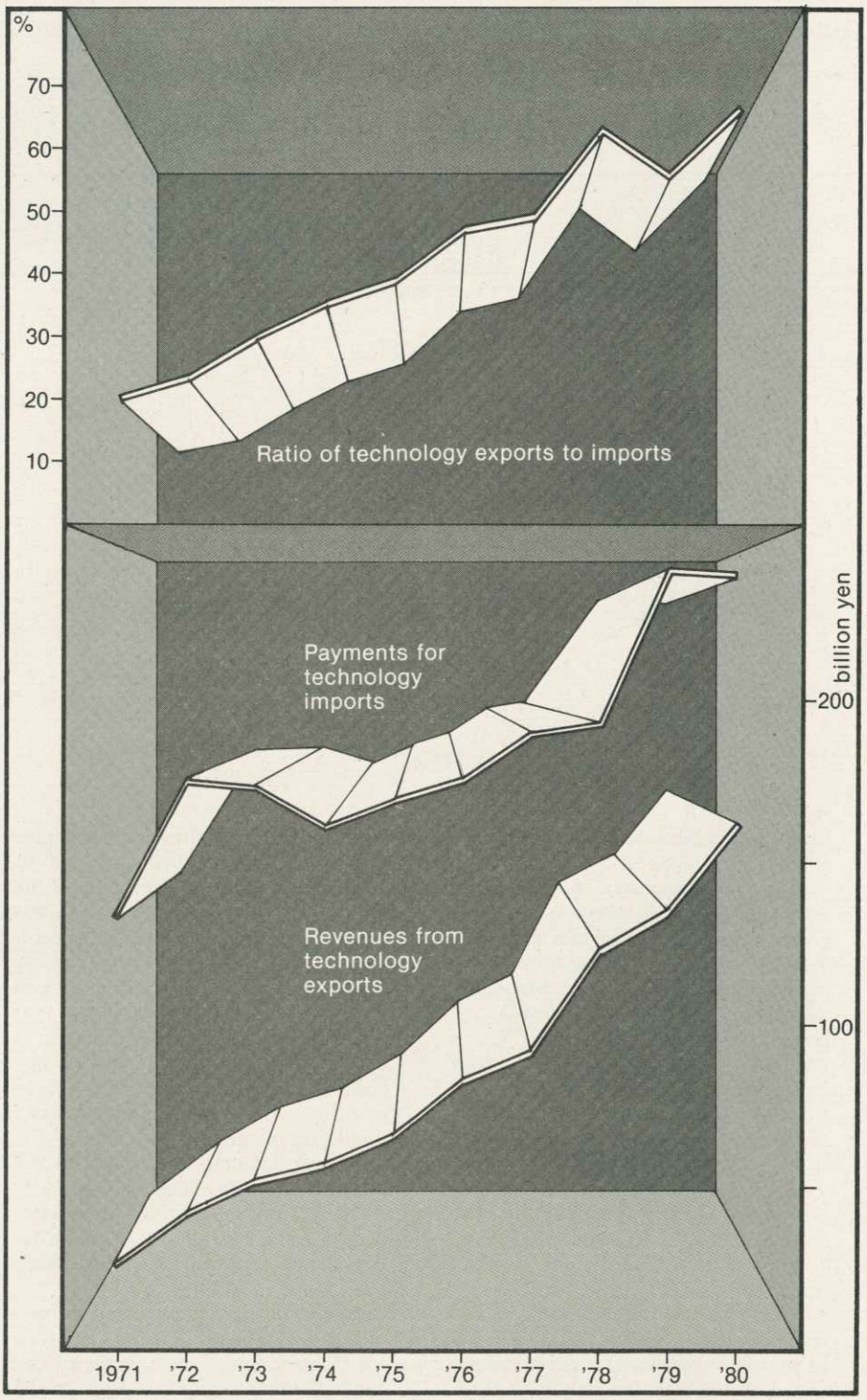
Recently there has been a sudden increase in the export of Japanese technology. For a long time, Japan has imported technology, making skillful improvements which have resulted in reliable products of high quality at low cost. This ability, coupled with strong competitiveness in international markets, has led to tremendous growth in industry during the three decades following World War II. With this solid industrial base, Japan has turned to the development of technology. Today, in a number of fields, including forefront technology, Japan ranks with the United States.

Figure 1 shows Japanese exports and imports of technology over the past ten years. Although import expenditures still exceed export revenues in the sum total of new programs and continued programs, the ratio of exports to imports is gradually improving, with exports now over 60% of imports.

As far as new programs are concerned, contracts concluded after 1972 show exports of technology surpassing imports in terms of payment. In 1980, exports totalled ¥74,263 billion compared to ¥27,675 billion for imports. In other words, export revenues were 2.7 times import expenditures.

One of the major contributing factors in Japan's technical improvement has been a substantial increase in investment in technological research and development, especially over the past four to five years. The annual growth rate of investment in the private sector was more than 6% in real terms during 1977 and has strengthened to over 9% during 1980. This growth in investment reflects thriving business in the field of VLSI, optical fiber, VTR, industrial robots, office automation equipment

Fig. 1. Technology Imports and Exports



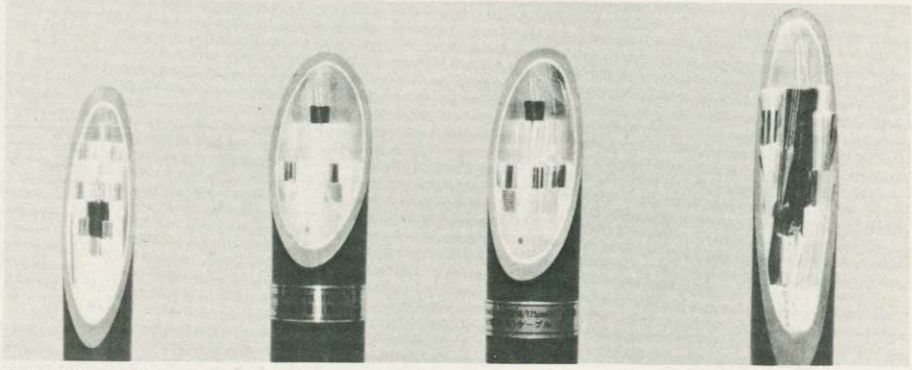
and pharmaceutical products, as well as rising expectations regarding technological innovations. Japanese companies are determined to liberate themselves from their dependence on America and Europe for new technology. These efforts have been further fueled by the success to date and the realization that new technological innovation is possible if pursued strongly enough.

Japan has now entered a new stage in the development of its technology. The strength of Japanese technology has traditionally derived from the principle of "the best for the least;" that is, reliable products of high quality at low cost. *The Best for the Least* is, incidentally, the subtitle of the English version of my book, *Japanese Technology,* published by Simul Press Inc. in March 1982. The original Japanese version, published in 1980, has been widely read. In my book I analyze the strengths of Japanese technology from social and cultural perspectives by examining social customs, institutions, national character and company behavior. I would like to refer to some of these points here as well.

One of the major strong points of Japanese technology is traditional emphasis on the shop floor or actual place of production. Large numbers of skilled engineers are put to work on production lines, and most of the managerial staff possess considerable and direct production experience. Because of the importance attached to production at the workplace, everyone from highly skilled workers to young beginners takes pride in his or her labor. Suggestions for product improvement are readily made, and workers participate actively in QC (quality control) circles. The common belief that the Japanese are skillful with their hands is an incomplete if not totally dissatisfactory explanation of Japan's success in this field. A better explanation is the way in which new ideas and methods worked out by individual employees contribute to the "the best for the least" principle of production.

Consideration for consumers and customers is another important strength of Japanese technology. There is a Japanese saying *Okyaku-sama wa kami-sama* which means "the customer is always right." Strenuous efforts are made to meet high customer expectations regarding quality, delivery schedules and price. Japanese customers are perfectionists who will not accept a product with even the most trivial flaw or defect. Furthermore, they demand design sophistication and strict adherence to deadlines and methods of delivery. The parts and materials necessary for production must be delivered on the exact date and at the exact time specified, arriving just as they are needed in order to minimize inventories. Even the biggest companies, such as Nippon Steel Corporation, have no choice but to comply with customer demands. And these efforts to meet customer demands contribute to the improvement and sophistication of Japanese products. Hence, Japanese technological advances are in good part due to the high standards demanded by customers.

The third strength of Japanese technology derives from the traditional miniature arts, such as *netsuke* (thumb-size sculptures), *bonsai* (dwarfed trees), *hakoniwa* (miniature gardens) and *kamidana* and *butsudan* (small altars for the home). The classical Japanese poetic forms of *haiku* (consisting of 17 syllables) and *waka* (31 syllables) express great depth of emotion in a few brief lines. Japanese have always taken pride in being able to condense considerable content into limited epitomizations.



Optical fiber for future communication systems

These characteristics of the Japanese people are well suited to the development of modern technology. In the field of electronics, for example, the most important element is size reduction and integration. The smaller the product, the better the performance and the lower the cost of production. It was only natural that Japanese technology should have advanced from the transistor radios, microphones and televisions of yesterday to the production of mini-calculators a mere 1.6mm thick, compact cars, mini components (for stereos) and VLSI, the most advanced area of technology in Japan today.

Small-size products are easy to use, energy efficient and low in production costs. Little wonder that Japanese products have become so highly competitive in international markets.

To summarize, many of the characteristics of Japanese technology have their roots in traditional culture and society, a point which has aided enormously in the implementation of "the best for the least" principle. Japanese technology has been developed in concert by engineers, workers at the shop floor level and customers. It may indeed be described as a technology with a solid foundation.

With the elements of creativity and inventiveness added to this solid foundation, Japan is now capable of developing technology equivalent to that of the United States in the state-of-the-art technological fields. This claim is substantiated by Fujitsu's having been able to submit the lowest bid last year to supply ATT (American Telephone and Telegraph) with optical communications equipment. Despite being the lowest bidder, Fujitsu lost the contract on national security grounds. The matter was given a good deal of coverage in the newspapers, and for Fujitsu, the experience was no doubt frustrating. However, seen from another perspective, the incident entailed an international admission by the American government of Japanese superiority in optical communications technology, the forefront technology. This may prove a significant advantage to Fujitsu in the future.

Japan has close to a 70% share in the U.S. market for 64K RAM (random access memory), the forerunner of VLSI. This fact has led to renewed friction between the United States and Japan in the field of semi-conductors. However, it was the success of market strategy rather than the technology itself which contributed to Japan's large market share. Japanese companies took considerable risks in going ahead with the mass production of 64K RAM at a time when there were numerous risks involved and little guarantee of the expansion of the market. U.S. manufacturers are likely to regain market share in the future.

Formerly the United States and Europe led in the opening of new markets, but this trend seems to be changing. Conditions in Japan were ripe for the technology of the 1980s, including forefront technologies. These technologies, typically represented by VSLI, including optical fiber, semi-conductor laser, CCD (charge coupled devices), carbon fiber and amorphous semi-conductors, were all discovered at least 10 to 20 years ago. The development of technology today aims for constant improvement in quality, mass production, minimum production costs and practical application. These are certainly the goals of forefront technology.

Today Japan has both the investment capital and the human research resources necessary to carry out research and development to the highest standards. Furthermore, the inherent cooperative spirit of the Japanese is well suited to research and de-

velopment requiring the coordination of hundreds of workers.

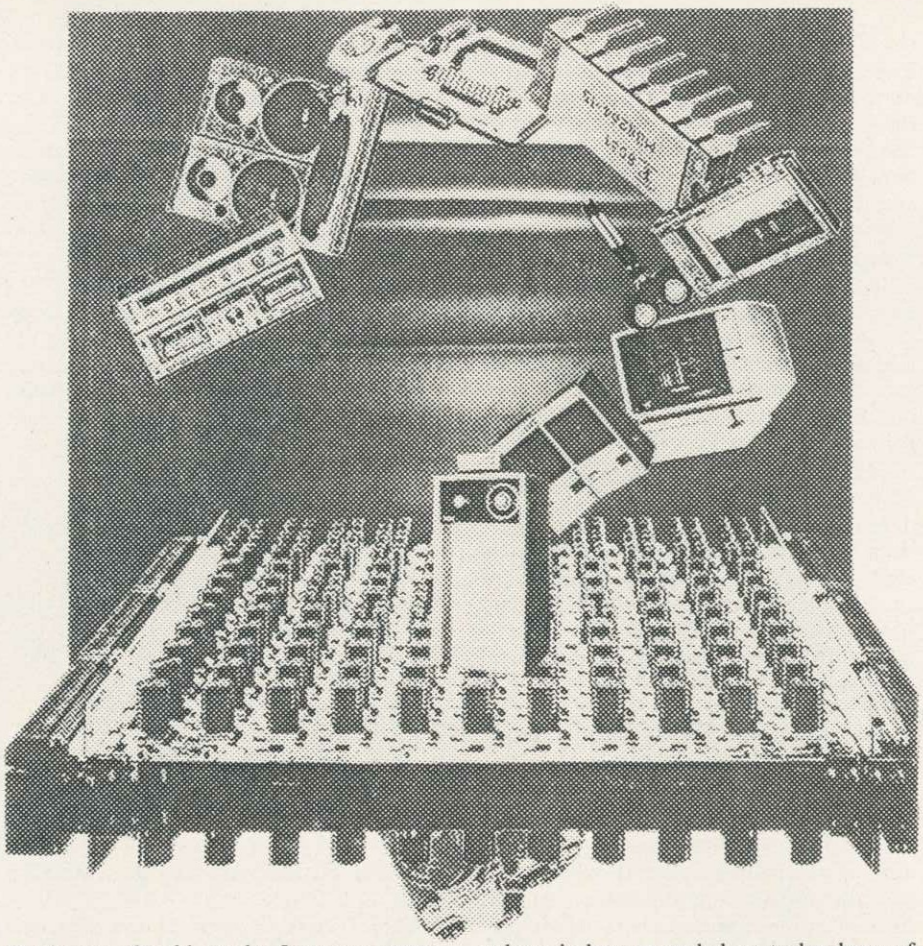
To avoid any misunderstanding, however, I must also stress that group consciousness does not imply mass obedience to an absolute leader. Were Japanese cooperation such a collectivism, we would never have attained our current level of technological development in VLSI and other fields. Rather, what exists is a situation in which even a young employee feels free to express his opinions, knowing his seniors will listen attentively. Japanese refrain from excessive self-assertion, emphasizing instead cooperation in pursuit of the shared goal. The company's goals are also the goals of every individual worker, and each works for their attainment.

Japan's future role and responsibilities include technological and industrial cooperation with foreign nations, and many possibilities in this area lie ahead. For example, the principle of "the best for the least" and, in particular, the elements which give rise to the principle, could be introduced abroad. Japan has not lost its strong industrial foundation with the new emphasis upon creativity and inventiveness. Other industrialized nations may be superior in the area of technical creativity but lack Japan's solid foundation because insufficient attention is paid to production at the shop level. Accordingly, moves have already begun in some countries to introduce QC circles and other distinctively Japanese manifestations of our emphasis on the workplace, as a means of enhancing production.

A second possibility includes technological assistance, participation in local production abroad, and joint development projects in the fields where Japan is leading. Once a technology-importing nation, Japan is turning into a technology-exporting nation. Already such programs are underway in the fields of VTR, industrial robots, large-scale computers and light-water nuclear generators. During the past year alone, Japan cooperated with other industrialized nations in 4 VTR and video disk projects, 5 industrial robot projects, 7 communication equipment projects and 6 large-scale computer projects. Technological instruction was provided in 27 iron and steel projects.

Technological assistance and joint development programs must be promoted in the future. However, language poses a major obstacle, and is at least partly responsible for Japan's continuing deficit in technology trade. All Japanese researchers and engineers can read Engligh, and many can read German or French. But how many foreigners are able to read Japanese? It is impossible to learn about Japanese technology without any knowledge of the language.

The language problem must be tackled from both sides. Japan should publish more papers and abstracts in English, and



foreigners should study Japanese more. Japanese technology is worth learning from in many fields, and this body of knowledge is growing at a rapid pace. In fact, companies without Japanese specialists may find themselves falling behind and missing opportunities in the future.

The third possibility is the promotion of basic research and development programs for future technology. Although state-of-the-art technologies in the 1980s basically developed from existing theories, technology in the 1990s promises to put new discoveries to practical application. Examples include the Josephson element in electronics, high-speed logic elements based on three-dimension circuit elements (vertical and horizontal layers of circuits in integrated circuits), large-scale memory, and fifth-generation computers which incorporate all such technologies in independent reasoning capabilities.

In the field of chemistry, the introduction of membrane separation (a method of separation and refinement which will radically alter the current distillation system now in use) and bio-reactors (application of biological effects) may bring about major changes in chemical plants.

Genetic engineering is another field of futuristic technology which promises to result in practical application by the latter half of the 1980s. Its growth as an industry, however, is unlikely to be significant until the 1990s at the earliest. This field of technology is best regarded as technology of the 21st century.

The United States, a nation involved in innovative experimentation, is forging ahead in the development of many fields of futuristic technology. By comparison Japan still lags behind in a number of areas.

However, Japan is also developing futuristic technologies in a variety of programs which should come to fruition after 1990. One such program is the promotion of technology for fifth generation industry under the auspices of the Ministry of International Trade and Industry. The Agency of Industrial Science and Technology as well as major private companies have also embarked on basic research and development for the future.

In the United States, many companies are taking up the challenge presented by such research and development programs. While risk is high, success would mean enormous profits. But in Japan, there are few examples of this kind of venture business and only the biggest of enterprises are willing to take the lead in the private sector.

The question now is therefore what achievements Japan can generate in these futuristic technologies. Japan should take on a larger role in the basic research and development of future technology and should report her accomplishments internationally. ●