17

History of Technology and Technology Policy

Politics and Modern Science and Technology

Although Japan has achieved technological self-reliance, it is not playing the lead role in all areas of technological development, and there should be no reason to expect that it should. It is sufficient for Japan to have appropriate areas in which it may contribute to the rest of the world, and any attempt to monopolize the potentials of development in technology would be dangerous. Especially in view of the military potential of the most advanced sciences and technologies, it is important that each country have some share in global science and technology activities, with no one country dominating.

To this end, establishing a world-wide science and technology information network would make an important contribution.

The institutionalization of science and technology has been occurring since World War I, and both in developed and in developing countries, government expenditures to promote science and technology have grown tremendously. In Japan, however, government involvement and investment have been extremely small, the leading role in research and development having been played by private enterprises. In other words, individual enterprises own the most advanced technologies. This is one reason why Japanese R. & D. has often been expressed as "r. & D."

There is the opinion that Japan won the competition for quality control but not for technology innovation. This reflects the difference between countries that have been engaged in developing science and technology mainly for military purposes—for which only high efficiency and quality have been sought and the possible general national economic benefits of them disregarded—and Japan, which has specialized in applying the theoretical achievements of modern science and technology for improving people's lives—in other words, for commercial purposes. It is totally unreasonable to have people dying from starvation in an age when man can go to the moon.

Everyone should be assured of the right to oppose the development of science and technology that has been inseparably connected with such political insanity.

The utilization of the most advanced technology for people's day-to-day living should be developed more positively in each country. Bolder experiments (with certain conditions) should be attempted in developing countries.

However, because industrialization and the development of science and technology involve the principle of private economy, they tend to be accompanied by such negative consequences as those discussed in the section on environmental pollution. Consideration for human dignity and human rights by scientists, engineers, and industrialists must be constantly promoted. As one scientist has described it, it is easy to understand that the most advanced areas related to military technology are the areas containing the most attractive challenges for scientists and engineers. It is most unpleasant, however, to see them exchanging, as an equal trade, the existence of mankind for personal gain.

In this regard, the charter promulgated by the Science Council of Japan in 1980 is extremely promising. The council declared three principles for atomic energy research: the research should be autonomous, democratic, and freely accessible to all.

The charter declares that "science must aim only at enriching the lives of mankind," and "in order to ensure the sound development of science and to promote its useful application," scientists must:

1. be conscious of the meaning and aim of their research and contribute to the welfare of mankind and world peace;
2. defend the freedom of learning and respect originality in research;
3. promote the harmonious development of all scientific fields and encourage the diffusion of the spirit and knowledge of science;
4. be alert to the abuse of science and make efforts to prevent it;
5. respect the international validity of science and promote scientific exchange around the world.

This welcome declaration was an achievement encouraged by recommendations of the Occupation forces intended to fundamentally reform the Japanese system of research and education after 1947 (Yuasa 1984). Just as the Japanese could not prosecute the war criminals on their own initiative, the internal circumstances of late-comer Japan were such that, unless there was pressure from the outside, it was difficult for people to gain the opportunity for change. What is to be noted is that inherent elements had matured so that Japan could respond to pressure from the outside. Under the Meiji state, the potential for reform in the worlds of science and technology had been limited.

Since the Tokugawa shogunate, two historical veins had intersected in Japan, distinguished according to how the idea of "Japanese spirit and Western technology" was used. In one, the idea was used to represent progress, while in the other, it was used to disparage Western technology as merely a tool borne of a culturally and spiritually impoverished world, and, at the same time, to promote a reactionary, exclusive nationalism.

Even as long ago as the ninth century, when Japan was actively importing Chinese culture and technology, there were those in Japan advocating "Chinese technology, Japanese spirit" (Yuasa 1984).

And again, 350 years after the introduction of the gun (1543) and of Christianity (1549) into Japan, the current slogan was "Japanese spirit and Western technology" (Yuasa 1984).

The defeat of China in the Opium War was a serious shock not only to scholars of Western learning but to everyone, leading to the publication of such arguments for coastal defence as *Kaikoku shidan*, a work by Hayashi Shihei. The defeat of China also triggered a shift in the Japanese scholarly community away from the Chinese model, as represented by the *T'ien-kung k'ai-wu*, a seventeenth-century encyclopaedia of technological science by Sung Ying-hsing, to Western science and technology.[82]

In the early nineteenth century, "Japanese spirit and Western technology" had a progressive meaning that continued until early Meiji. However, with the establishment and stabilization of Meiji state power, the nature of the idea began to change, and an abusive manipulation of technology began. The tendency was most marked among military officers and conservative politicians, and there was little public resistance.

According to Yuasa (1984), it was some 50 years before anyone appeared to object publicly and persuasively to the contempt of science and technology that "Japanese spirit and Western technology" was being made to represent.

In 1915, Tanakadate Aikitsu (a science professor at the University of Tokyo) gave an address to the House of Peers (which was led by ultranationalists and Shintoists) under the little, "The State of Aircraft Research and Development," in which he campaigned for the establishment of an institute of aviation:

> In my understanding, you regard Western civilization as a materialistic, mechanical civilization, a physical civilization devoid of spiritual aspects. You maintain that the Oriental civilization, on the contrary, is metaphysical and spiritual, and that humanity, justice, loyalty, and filial piety are the specialties of the Orient, and your concern is how to harmonize these two currents. However, my question is whether or not we can define Eastern and Western civilizations in such a simple way. . . . I doubt if Western civilization has been established on such a shallow foundation.

Adducing the heliocentric theory of Galileo, he continues:

> Once he had concluded that the earth revolves around the sun, he resolutely maintained his conviction. . . . Such an attitude cannot be taken to be from intentions to make money, attain fame, or the like. Perhaps this is the mind that lodges behind what is called the materialistic Western civilization. It seems to me that there are many living Galileos and Newtons in contemporary Europe and America, and they are cultivating the source of civilization.[83]

In this, we can recognize, beyond the digressions peculiar to Japan, the establishment of modern scientific thought with a universal nature. Nonetheless, this kind of thinking was not victorious over the transformed notion of

"Japanese spirit and Western technology." Those who supported the military fascist regime, which was interested in Western science and technology only as a means, were aware, on the one hand, that the outcome of any modern war was a matter of scientific and technological potential, but, on the other, as a serious contradiction, rejected the "ideas" inherent in modern science and technology, thus finally leading to self-collapse.

Unfortunately, there was a revival of the pre-war notion of "Japanese spirit and Western technology": the new version held that Japan's loss in World War II was a defeat of its scientific and technological capabilities. Post-war reconstruction of Japan was therefore to be aimed at Japan becoming a great power through development of its science and technology.

The conflict here is an antagonism between the nature of politics and the philosophy of science and technology. The relationship between science and politics has reached a critical point in the present age. Tanakadate cited Newton and Galileo, who lived in a time when science was not yet institutionalized, was politically independent. The moral difficulty of scientists in more recent times was well represented by Einstein. As a result of the institutionalization of science, however, modern scientists now constitute a part of the power élite, and one would be hard put to find an Einstein among the agrochemists who developed Agent Orange or the economists who discuss the kill ratio of a particular weapon and their like.

These people are unaware that they are "fierce animals" bred as specialists of knowledge and technology within the state system of the United States. They are "specialists without spirit and sensualists without heart." The contemporary age is one of a gigantic institutionalized science. An analogy may be drawn from the mafia chieftain who is also a devout church-goer, activities that in his consciousness are non-contradictory. This unconscious schizophrenia has debilitated modern scientists and engineers.

There have been criticisms and warnings from the scientific community against the induction of top scientists into the bureaucratic power structure, and therefore I need not take the matter up here. Among Japanese scholars, Hiroshige Toru and Nakayama Shigeru have published excellent works.[84]

In this regard, we can be sympathetic to the warnings and hostilities of the participants in our dialogues concerning specialists in science and technology, although their criticisms are stereotyped and lack concreteness. The privileges and influences of the élite in science and technology are as great in developing countries, in which the absolute number of scientists and engineers is small, as in the superpowers. In such circumstances, there is no other body of scientists in these countries that could act as a counterbalance, a check to those who become a part of the power élite. What is worse, those élites continue in office even after changes in government.

Technology Policy for Development

Nakaoka (1986), in tracing the history of modern technology in Japan, points out the surprising similarities to development in the West. Indeed, while

Japanese technological development has been unique, it constitutes a part of a world-wide trend in technology development, and therefore no country need follow rigidly the particular developmental pattern of any one country; rather, each should choose the one most suited to its special needs and conditions.

Focusing on the Japanese iron-manufacturing and cotton-spinning technologies, Nakaoka concentrated on management, labour, supporting technologies, and related services. He examined Japan's lag in comparison with the development stage of iron-manufacturing technology in the West when Japan started and how it caught up with the West. He emphasizes that the existing large stock of skills and accumulated technology in Japanese traditional iron-manufacturing was of critical importance, in spite of the fact that the scale of production was small and equipment was primitive.

At Kamaishi Ironworks, for example, a shortage of charcoal forced the plant to switch to coke for fuel. The attempt to manufacture coke failed, however, due to an incomplete understanding of the manufacturing process, and it was not until management was privatized that success came: the scale of operations was reduced to balance the supply of fuel with demand, and the links with transportation and other services were rationalized.

Nakaoka emphasizes the critical role played by the establishment and adjustment of linkages with such peripheral factors as fuel, power source, and transportation problems in determining success or failure. He also observes that the time required for each stage of development in the West was considerably shortened in Japan (a total of 400 years versus about 50), "as if the Buddle blast-furnace had actually been skipped over."

Nakaoka also examined the history of the modern development—after passing through the three stages of its early development—of the textile industry, which confirmed the importance of related technology and supporting services. He also traced two significant transformations: (1) from management by administrators to management by business professionals and the formation of skilled labour and (2) from the employment of farm labour, which is completely unaccustomed to the systematized, regulated working conditions of a factory, to the employment of factory workers.

Nakaoka stresses the significance of fringe technologies in spinning as the crucial elements leading to Japan's industrialization success. The technology for manufacturing wooden machines, for example, was developed by the makers of looms and water-wheels, who had high-level engineering skills. Native technology was joined with imported Western technology to form an intermediary, or hybrid, technology. The mechanical systems, key parts, and energy sources were Western, and they were combined with native Japanese parts etc., to create the necessary linkages and stages in the production process. Toyoda Sakichi, for example, invented the automatic loom using imported cast-iron parts for the key components, while the rest was constructed of wood. Toyoda was able to duplicate the metal English loom by cleverly combining local materials and know-how with those from the West.

Ishii (1986) makes reference to a kind of technological linkage in which a new technology does not replace traditional technology; rather, what is

fostered is a coexistence of mutual prosperity through the realization of a supplementary relation whereby, taking cloth-making as an example, the spinning is done by labourers at the factory, while the weaving is done by part-time workers at home. In this example, the most difficult and labour-consuming processes were performed by modern machines in the factory, while the weaving process could be done at home in the traditional manner because the Japanese market demand was for narrow cloth, suitable for use in the making of the traditional kimono. Western weaving machines were capable only of producing broadcloth, and so they were installed in the factories for weaving cloth to be used for military uniforms and cloth for export to other Asian countries.

Incidentally, the development of cotton spinning placed cotton ahead of linen among textile materials. In the present age of chemical fibres, on the other hand, goods made of cotton or linen have come to be considered luxury items.

Regarding technology policy, Uchida (1986) examines the history of technological policies from 1825 to 1935, dividing it into four periods. He described the characteristics of each as follows.

The first is the period up to the Meiji Restoration (1825–1868), when the prototype of the Meiji government's technology policy was to be found in the policy of the Tokugawa shogunate and other feudal clans. This was also the time when absolute government control over technology and information was crumbling as a result of both internal and international events. The promotion of industry by feudal clans as a financial policy to increase cash revenue would form the basis for the new government's central policy of industrial promotion on a national scale. Since the establishment of the Tokugawa shogunate, the samurai class was evolving from one made up of warriors to one of administrative bureaucrats, which aided the government in its formation of an administrative apparatus and the development of needed economic and technological policies.

The second period (1868–1885) was characterized by impetuous Westernization represented by model factories under direct government operation in which not only were the equipment and machines imported but the engineers and foremen were also brought over from abroad to provide operational guidance. In 1873, the number of such foreigners totaled 239 (from 1875, the total number began to decrease). In this period, however, the government had no comprehensive technological programme or technology policy. Opinions were divided among leading politicians, and each government office was engaged in its own programme of technology importation and personnel training, with no integration at the level of the central government.

In the third period (1885–1910), there was an important policy change: for the first time bureaucratic management of state-run factories gave way to private management, as a direct result of accumulated debts and fiscal difficulties of the central government. The change of policy was accompanied by a movement of personnel from government enterprises to the private sector,

which provided an opportunity for a broad dissemination of technology. On the other hand, in such areas as railways, meteorology, and communications, which were kept under government control, each ministry established its own school to train and secure human resources. Laboratories, research institutes, and experiment stations were established for agriculture, industry, and fishery technology in this period.

The technology policies of the army and the navy were characterized by a strong inclination for weapons independence (home production, uniformity, and standardization). This goal was attained by the beginning of the 1910s (though later for the navy, because of the nature of its weapons).

Self-reliance in technology was achieved mid way through the fourth period (1910–1935). At this time, the minimal linkages among technologies had been established on a national scale and a new stage of development then began. Though in the past military technology and science had been strictly in the hands of the government, in this period, further technological development required the participation of the private sector. The military's policies aimed at Japan becoming a superpower corresponded with the government's goal of making the country a first-class industrial nation.

In this (last) period of tremendous development of the heavy and chemical industries, the machine and chemical industries, under the momentum provided by World War I, were able to substitute their own products for imports, thus bringing to a halt their costly purchases of many goods from abroad. Also in this period, newly-risen *Konzern* formed big business groups with the technologies of the heavy industries as their central pillars. One such group was the Institute of Physical and Chemical Research, which was transformed and enlarged from the Institute of Basic Science Research, established with government assistance in 1916.

Uchida concludes that it was only with the establishment of a technology agency in 1942 that technology became an independent item in Japan's total national policy.

Addendum

Concerning post-war science and technology policy, the establishment in 1959 of the Science and Technology Council was significant. Its members include the prime minister (chairman); minister of finance; minister of education; director-general of the Economic Planning Agency; director-general of the Science and Technology Agency; chairman of the Science Council of Japan; and three others appointed by the prime minister. This represented an unprecedentedly powerful system for the administration of science and technology. Prior to the establishment of this council, the Science and Technology Agency (established in May 1956) had been active in carrying out the administration of science and technology, aiming at the promotion of science and technology to contribute to the development of the national economy.

According to Yuasa (1984), the two 10-year programmes established by

the Science and Technology Council, that is, (1) the "Basic Measures for the Promotion of Science and Technology Aiming at Ten Years Hence," of 1960, and (2) the 1977 "Science and Technology Policy in the Age of Limited Resources—A Basic Ten-Year Programme," were extremely significant. Though monotonous and long, the government documents describing the programmes provide us with a good picture of the problems Japan faced.

The response by the Science Council of Japan to the 1977 proposal was summarized as "Science and Technology at the Turning Point" (1978). This and the "Scientists' Charter," published by the Science Council of Japan in 1980, make a pair. It is noteworthy that in the charter, Unesco's "Recommendation on the Status of Scientists" was interpreted as both a "charter of rights" and an "ethical code."[85]

In a study, "The Historical Development of Science and Technology," conducted by the Policy Research Group and chaired by Sassa Manabu, the call was made for a new, holonic and flexible path of scientific and technological development in view of the observation that there was a trend toward overspecialization (atomism) in science and, at the same time, the creation of Big Science.[86]