Science and the Rising Sun

by F. Roy Lockheimer

Creative science in Japan needs cultivating — a specialist in Far Eastern affairs tells why.

Japan is the only Asian country to have industrialized successfully, and it has done so extremely well. Japan today is first in the production of ships, second in the production of automobiles, third in the production of steel in the world, and will very shortly, I predict, become the fourth nation to launch its own satellites with its own rockets. All of this adds up to the somewhat startling fact that Japan is today the third most significant industrial unit in the world. That is quite a development in less than 100 years.

In nearly every aspect of its national life, Japan was a well-developed society in the middle of the 19th century—perhaps more developed than some underdeveloped countries are today. Every field of endeavor that existed in the West flourished in Japan before 1868 except science and its ensuing technology. In the mid-19th century, however, after 250 years of almost complete seclusion, Japan was abruptly shaken out of its isolation by an expansionist West whose source of strength stemmed from a rich scientific tradition that was unknown in Japan. At the same time, internal tension had brought the country close to dangerous strife at the highest levels of government. The old regime was weak, near the point of collapse.

Yet, within 15 years after the appearance of Perry's ships, Japan had not only set its house in order, but it had also launched a wildly successful program of nation-building along Western lines. *Fukoku kyōhei* ("rich country, strong army") became a national password, and priorities were adjusted accordingly. If the country was to become a Western-style power, then Western science would have to be imported just as it was. While Japan possessed an artistic and philosophical basis for exchanging ideas with the West at all levels, it had no basis for a scientific exchange and thus no possibility for adaptations and modifications to lead to new approaches.

Even before the government was stabilized and had begun introducing Western science into the nation, almost 100 Japanese had been abroad for foreign study. Although this number may not appear large, its significance becomes clearer when it is realized that as a general rule foreign travel was prohibited. The government itself sponsored study abroad for the first time in 1862 and by 1868 had sent 47 students abroad for study in France, Great Britain, the Netherlands, Russia, and the U.S.

Time was not wasted on "frills." Whatever was needed to make the nation prosperous and strong received emphasis: medicine, gunnery, engineering, general science, agriculture, manufacturing, and commerce. By 1912, more than 65 percent of all the students who had gone abroad for study under sponsorship of the Ministry of Education had specialized in the "hard" areas of the basic and applied sciences, especially the latter. (The only other major emphasis was on legal studies—encouraged to help make Japan strong and independent.)

The government was dedicated to strengthening the country as rapidly as possible. If desired results could not be obtained at home with native talent, or if study abroad proved inadequate, then what was needed could be imported—not only foreign teachers, but foreign technology, patents, licenses, and pub-

lications. All was done at great expense, but with spectacular results. The goal of developing Japanese science was certainly a long-range one, but for reasons of expediency rather short-range measures were adopted—with the result that even today Japan is without a strong creative tradition in basic science. There comes a time when the price of foreign technology becomes too high.

JAPAN ADAPTS TO WESTERN SCIENCE

Japan was able to receive Western science, and adapt it to its purposes, because by the mid-1800's existing conditions were quite conducive to the development of science. The country had a flourishing culture based on a settled agricultural economy, with educational institutions, communications, a bureaucracy, and a tradition of scholarly discourse, as well as some preliminary accumulation of scientific knowledge by individual scholars who had limited contact with Western scientific publications. It was also a national entity—a state. Japan possessed large cities and a developing national economy. The country was not divided by differences in language or culture; on the contrary, the insularity of the Japanese islands had engendered strong feelings of unique identity among the people. The tradition of centralized government and bureaucracy was a valuable legacy, as was a well-developed national system of education.

No matter how well endowed a country may be in the prerequisites for science, its society may not respond favorably—or even with monumental inertia—to the introduction of scientific concepts. But once science is broadly introduced and well received within a society, then social change is bound to occur. Japan's experience is testimony to this process.

Japan's natural insularity made the Japanese suspicious of foreigners, but it also made them very curious about the outside world. Even before the 16th century they had shown great interest in Chinese cultural achievements, many of which they adapted to their own use. Acceptance of foreign ideas, therefore, was not a new aspect of Japanese history by the 19th century. Informed Japanese could understand that their country did not have all the answers, that there was much to be learned from the outside world.

The Japanese are keenly competitive, success-minded, goal-oriented people. Causes, conditions, and circumstances change, and when they do, Japanese values change with them. If the majority of the Japanese were anti-foreign when Perry attempted to end their isolation, in less than 15 years those same Japanese were reaching with enthusiasm for Western ways. Three generations later, another majority of Japanese were convinced that their nation was invincible and that they would fight to the last rather than surrender, but after a few short and painful years, they surrendered in all meekness, submitting to defeat and occupation at foreign hands. Why? Part of the explanation in both cases for this amazing change in national attitudes is that national circumstances had changed; therefore, so did national goals. The Japanese drive for success was not altered; they simply adjusted to new goals, which now seemed proper against the background of their new environment.

Japan's value system, with its situational ethic and goal orientation, allowed the nation an extraordinary receptivity to science after 1850, much in the same way that it allowed the population to behave with dignity and cooperation while under the occupation of a formerly detested enemy after 1946.

But it is one thing to recognize national needs and quite another to respond quickly to fulfill those needs, even with a high degree of national receptivity to foreign concepts. Leadership is required. This leadership was undertaken by the Japanese government, beginning a tradition of governmental initiative and bureaucratic influence in the sciences that has continued to the present.

THREE PERIODS OF SCIENTIFIC GROWTH

A broad view of the development of science and technology in Japan over the past century shows three main periods of growth: (1) 1868 to the outbreak of World War I, 1914; (2) the interwar period, 1918-1937; (3) the period after World War II, 1945 to the present.

The first period saw the establishment of many of the basic educational institutions that had the responsibility of training native scientists. The University of Tokyo was founded in 1877, then reorganized and combined with the college of technology in 1886 as Tokyo

Imperial University. The government-sponsored ordinance which defined the character of the Imperial University stated the school's purpose clearly: "The aim . . . shall be to teach and study such sciences and practical arts as meet the demands of the State." Other imperial universities were established in Kyoto, Sendai, and Fukuoka. As early as 1884, an astronomical observatory was established at the University of Tokyo.

The first steps taken by the government toward the development of native science and technology were more internal ones, however. A ministry of engineering was established in 1870, and under its aegis the building of railways and lighthouses, the erection of telegraphic services, and the development of modern techniques in mine and factory management were all implemented.

NATIONAL POWER—FIRST PRIORITY

During the second major period of Japan's development of science from 1914 to 1937, tremendously significant advances were made in heavy industry and its supporting technology, again with the building of national power receiving first priority. Electricity, gas, chemicals, ceramics, metals, machinery—all employing the most recent improvements in technology and in methods of mass production—made large strides forward. But, faced with the prime responsibility of expanding national power, Japanese science during the interwar years did not have time to keep up with foreign scientific developments.

The interruption in scientific communication caused by the outbreak of World War I made the Japanese realize how dependent their science was on foreign sources of information. Japanese attention was drawn to the task of creating an independent foundation for scientific research, again largely under government initiative and direction. Although concern was expressed at the time about the need to develop a better foundation for basic science, it is probably fair to say that the *raison d'etre* of the new research institutes was to serve industrial and military technology.

With the launching of its program of aggression on China in 1937, Japan's science and technology were mobilized for war. Basic science, the investigation of phenomena for the advancement of knowledge without necessarily seeking practical applications, never was given a chance to take root in Japanese soil. The brief period of promise after World War I, when there was a slight opportunity for the development of independent science in Japan, went unfulfilled. Within three generations, science in Japan had progressed from magic to a foundation for national development—only to suffer an almost disastrous blow from the distorted influence and increasing isolation brought on by the military adventures that eventually led to defeat in World War II.

Japanese science did not grow during World War II. Some important technological innovations were made to meet wartime requirements, but, duplicating the experience of World War I and with very much increased gravity, Japan was cut off from worldwide scientific developments.

Defeat in war brought Japan under military occupation for almost seven years, during which time significant change was wrought in the organization of national science and technology. In the early days of the occupation, scientific research in Japan almost came to a halt. Any investigation that had military implications was naturally prohibited, especially studies concerning atomic energy. Interestingly enough, Japanese investigation of the effects of atomic bombings was not entirely prohibited. Gradually, as the occupation developed more confidence in itself and in the Japanese, the resumption of research was permitted, and in some cases even encouraged.

ADVICE TO DEMOCRATIZE

One of the recommendations made by American scientific advisory missions to the occupation authorities was to discourage the Japanese tendency to organize science and scientists on a hierarchical basis. As a result, the occupation encouraged the democratization of the Japanese scientific world on all fronts. The establishment of the Science Council of Japan (SCJ) in 1949 was a direct result of this occupation policy. The primary aim of the SCJ was to mobilize professional talent in all fields to advise the government in the development of science and technology, research utilization, research training, scientific administration, and the infusion of science in-

to industrial and national life. Unfortunately, drastic changes occured in the Asian political setting in 1949, and, as a consequence, relations between the government and the occupation authorities on one side, and the SCJ on the other, became increasingly strained. Japanese science since that time has been heavily political through the efforts of various groups.

SCIENCE FOR WAR AND PEACE

The shibboleth of politically oriented Japanese scientists is peace, and consequently all research becomes divided into two categories: peace and war. This extreme sensitivity to possible military applications of scientific research —both a legacy from wartime experience and a requirement of postwar conformity to an anti-military posture—has caused, for example, serious delays in the development of Japanese space science. Research in rocketry may be permissible, the reasoning goes, but since guidance systems help to turn observation rockets into war missiles, guidance systems had better be avoided. Research on guidance systems was not emphasized for a long time at the University of Tokyo, and, perhaps as a consequence, the university has yet to achieve success in orbiting a scientific satellite.

During 1966 and 1967, the University launched three Lambda rockets, somewhat similar to the American Scout rocket. The primary design purpose of the Lambda was probably not to launch a satellite, but there was some possibility that it could, so the Japanese decided to see if it would work. The Lambda Rockets were launched from Uchinoura, the most important space base in Japan, which is run by the University of Tokyo. The Ministry for Science and Technology has yet another base in Tanegashima, and there is a military base on the island of Niijima off Tokyo. This points up the division in rocket research sponsored by the government, by education, and by the military. The scientists who engage in rocket research for the military do not participate in the space research activities being carried out at the University of Tokyo, primarily because the university wants to develop rockets only for peaceful purposes.

If the politicizing of science and the hypersensitivity of certain scientists to alleged schemes of the military to control research activity are unhappy conditions that evolved out of the occupation period, the increased participation and greater mobility of Japanese scientists are decidedly happy results. Although the occupation wrought these changes in attitudes as well as others in scientific education, in the organization of research institutes and scientific societies, and in the direction of international scientific exchange, the foundation of science in Japan went unaltered.

Government initiative and the importation of foreign technology remain the basic keystones of science in Japan. Creative science has yet to come to full bloom. Like other nations, Japan cannot escape the influence of its history. The old master-apprentice relationships, the custom of secret techniques, the prestige of the national over the private universities, the tendency to departmentalize and equalize research, the consciousness of a hierarchy and mutual exclusiveness among researchers in universities and in industry, the fear of military applications—all of these factors have worked both to impair scientific cooperation and to hinder the development of creative scientific traditions.

THE LESSON TO BE LEARNED

After a century of development in the sciences, the problems of basic science and the development of its creative aspects are beginning to be given national recognition in Japan. The country is groping for the establishment of a national science policy. Such a program might go a long way in replacing jealousy, suspicion, rivalry, and shortsightedness with scientific cooperation.

The most important lesson that can be drawn from the Japanese experience is that no matter how much effort is spent on building scientific traditions swiftly, there is neither a shortcut nor a substitute for the development of a nationally based, cooperatively organized, research foundation for the stimulation of creative, basic science. Science through government initiative and foreign technology, and science for national power, may offer significant encouragement for the growth of native scientific traditions, but creative science does not appear to flourish until scientific research is supported for its own sake, without any immediate thought of practical applications.