

〔共同研究：日本的経営の諸問題〕

## RESEARCH AND DEVELOPMENT IN JAPAN

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This paper tries to elucidate some characteristics of R & D in Japan. One of the reasons why industrialization in Japan has been so rapid and smooth in such a short time is the introduction of foreign science and technology. Since the Meiji Restoration the government and enterprises in Japan have sought to develop technology in order to build up "a rich country with a strong army" and to promote "production and business". And this has been largely made possible by the help of foreign science and technology.

Similarly, after the end of World War II, Japan has achieved remarkable development and economic growth, because of the active policy of introducing Western new technology. Without this policy, the economic rehabilitation and the development of mechanical and chemical industries in particular would not have been possible. Therefore, of course, the introduction of foreign technology has played an important role not only in the field of the economy, but also in the socio-cultural domain.

First, we considered the introduction of foreign technology in prewar, and secondly that of postwar period. Here we have pointed out concretely the rapid increase in manpower and funds invested in R & D. Thirdly, in spite of this increase in personnel and budget, we can not help admitting, to our regret, that R & D in Japan has not been fully developed. Fourth, we have explained the reason why original R & D in Japan has been lacking.

The aim of this paper is to point out some of the characteristics of R & D in Japan, and to inquire into the reasons why these features have appeared. To begin with, for Japan the development of technology was very important in order to "take off" rapidly from the traditional stage and gain independence also in the technological domain.

There are many reasons why Japan's industrialization has been possible in so short a time. One of these reasons certainly was the introduction of foreign science and technology. Broadly speaking, the modernization of Japan started in 1868, the year of the Meiji Restoration. Of course, even before that time, Japan has been able to import some foreign technology. But until the decline of the feudal Tokugawa Government, it was very diffi-

cult to introduce it formally. After its demise the Meiji policy makers have been pushing toward industrialization. Their policy had two objectives, one was the aim of building up a rich country with a strong army, and the other was a plan for increasing production and business. Of course, both objectives were closely related to each other, since the aim of enriching and strengthening Japan was enhanced by propping up production. In short, the policies of those days were initiated for the sake of national defence and the promotion of business. In initiating industrial activities, the Meiji industrial policy and its leadership had to rely heavily on Western science and technology.

Similarly, after the end of World War II, R & D in Japan achieved a remarkable

stage in the economic and technological field, because of the endeavors of the government and the efforts of business leaders toward introducing Western science and technology. Without such importation the economic rehabilitation and the development after the war, especially in the mechanical and chemical industries, would not have been possible.

### 1. The Background of R & D in Japan

Many explanations have been advanced for its takeoff and for the process of industrialization before World War II. The factors most often cited are the following:

(1) The close relationships between government and business, at least with several major joint enterprises. As an extreme case we could call to mind the image of the 'Japan, Incorporated'. "The Government may provide leadership for business by goal setting which is usually the result of consensus between government and business".<sup>1)</sup> The government maintained monopolies over a few key industries such as iron and steel, armament, railroads, telephones and telegraphs. Especially these industries sought to import foreign technology. On the other hand, the majority of medium and small industries remained in the private sector and were subordinated to the former. "The Japanese financial structure is designed by powerful industrial groups and the government to absorb funds from the entire Japanese economy and to feed them into the bigger companies".<sup>2)</sup>

(2) The Japanese entrepreneurial and managerial skills, i. e., the traditional family ideology or philosophy of the company that was regarded as a family, the manager play-

ing a father role, and the workers accepting the role of "children". This family paternalism was seen as a good model for the human relationships in business organizations. It was stimulated by Confucianism, which stressed five key relationships, that is, affection between father and sons, respect and loyalty between master and servants, harmony between husband and wife, precedence of the elder before the younger, and, lastly, trust between friends. These points have been pointed out by many observers of Japanese business and organization. For example, J. Hirschmeier, R. N. Bellah, R. Dore and M. Y. Yoshino. Yoshino has pointed out that it was more meaningful to view the early Meiji entrepreneurs of the innovation type as being a product of the samurai ideology. Its important characteristic was a sense of public consciousness, a concern for public welfare, and a strong nationalistic spirit. These attitudes were a product of Bushidô tradition and Confucian philosophy.<sup>3)</sup> Of course these value systems have changed year after year but on the other hand some features have remained unchanged in some particular way. Such an ideology also provided some kind of social control resulting in well regulated, hierarchically oriented organizations and groups. Moreover, this entrepreneurial ideology was of great use for the industrialization. It provided a strong justification for it, and as such was indispensable to the national interest.

(3) There was an abundant and well educated labour force produced by the educational system, public and private, which, in turn, was made possible by a strong aspiration toward school education. Facing a large technological gap during the Meiji Era, the Japanese government sought to establish common pub-

1) Kaplan, E. J., Japan, the government-business relationship, 1972, pp. 15-16.

2) Rebuschung, J., Japan, the facts of modern business and social life, 1977, p. 47.

3) Yoshino, M. Y., Japan's Managerial System, 1968, pp. 53-54.

lic schools as well as facilities for higher education. Meanwhile, Japanese business was in need of cheap labor for which elementary schooling was sufficient. In the process of industrialization business companies competed with one another and were obliged to prevent labor turnover of worker mobility. Then, the large scale industry started to train and teach skills to workers, that is, they started on the job training, adopted life-time employment and the system of seniority.<sup>4)</sup>

(4) Rationalism and realism in the attitudes towards science and technology are also Japanese characteristics. Presently, for example, the majority of the Japanese do not consider themselves believers of a particular religion. In addition, the religions that exist, largely stress inner-worldly values rather than those of the after-life. They emphasize the achievement of prosperity, happiness and health. Children in elementary school are taught the traditional ethical values together with rational and practical orientations. Generally speaking, the education in Japan has emphasized these two different aspects of social life as inseparable and closely related attitudes. In one word, the educational system in Japan sought to realize the so called Japanese Spirit with Western Learning.

## 2. The Postwar Period

After World II, from the late 1950's till the first half of the 1970's, R & D in Japan developed rapidly on the background of its prewar heritage. Particularly, many engineers, technicians and skilled workers received prewar practical education. This period after the war was called "the stage of high economic growth". Here we can see rapid

4) Concerning this point, cf. my article "Technical Education in Japan" in St. Andrew's University Sociological Review Vol. 14 No. 1 1980, (forth coming).

changes in the social and economic conditions. Especially there are the enlargement of business organizations and the economic scale in general, entailing mass production and consumption typical of a post-industrial society. Notable also is the rapid development of high-level industrial technology.

The technological development at this stage of high economic growth largely depended on Western new technology. Japanese industries have sought to introduce it, because at that time the domestic technology itself was inferior to its prewar level. Several problems arose, related to this so called "technological gap", which also existed in the West, namely between the advanced technology in the U. S. A. and that of Europe, whose countries were afraid of having invested huge amounts of capital in research by U. S. A.. In Japan the discussion about this technological disparity began in 1968. The subtitle of the White Paper of Science and Technology at that time was "The Promotion of Original, Indigenous Technology". In other words, in order to overcome the gap, the government wanted to look for new ways of creating original, domestic technology. Japanese business, however, anxious to get ahead, sought energetically to import foreign technology from the advanced countries.

At the same time, government and business alike strove to increase the personnel engaged in R & D, engineers, technicians and skilled workers. They also eagerly increased the necessary funds for research and hastened the active transfer of technology.

## 3. What is Original or Domestic Technology ?

Of course, R & D can be classified from many points of view. In general, there are the classifications of basic research, applied

research and development; exploratory research, fundamental research, applied research, development and so on.<sup>5)</sup> But there few classification has been done from the standpoint of the relations between technology and the nation, in spite of the fact that R & D was important for national policy and economic development.

Before discussing the need for original and creative technology in Japan, we must ask the question what original technology is. In general, as technology is concerned, the concept of "originality" can be contrasted with that of importation. Though the former can be distinguished from the latter on several other points, we want to focus on the following two aspects: (a) the connection with foreign technology, and (b) independent, new ways of research and the further development of existing technology. Using these two aspects, we are able to distinguish four types of technology: (1) The type that, being based on the traditional technology, has weak connection with foreign techniques. This we may call the purely indigenous or domestic type. (2) The type that, though built on traditional technological knowledge is closely related to foreign technology. This we may call the improved type. (3) Another type would be one quasi unrelated to either foreign or traditional technology. This would be the creative type. (4) Lastly, we can think of a type that has no connection with indigenous technology but is totally based on outside knowledge. This can be called the imported type.

The purely indigenous or domestic type of technology will not be found easily in far advanced fields, since these necessarily de-

5) R. N. Anthony and J. S. Day, *Management controls in Industrial Research Organizations*, 1952, p. 58, and C. C. Furnas, *Research in Industry*, 1948, p. 4.

velop by transferring technological knowledge. The improved type is common in the situation where the transfer of technology from advanced countries to developing ones is difficult, or, for some reasons, obstructed. The creative type is attributed to original innovation and discovery, made possible by genius or the building up of effective organization of R & D. The imported type, of course, is found in the instances where the transfer of technology is being resorted to.

After distinguishing these four types of technology, we will now consider the actual state of R & D in Japan.

#### 4. Manpower and Funds

As a matter of fact, the R & D in Japan has improved rapidly since 1960. On the whole, the people engaged in R & D include researchers, assistant researchers, technical and other assisting personnel. Their total numbers have increased 5 times during the period 1953-1975, from 95,000 to 490,000, while the researchers proper increased 10 times during the same period, from 24,000 to 255,000. Further, the funds invested show an increase of 6 times, from ¥450,000 million to ¥2,600,000 million (1965-1975). The G.N.P. percentage of R & D expenditure was 1.64% in 1962 and 2.61% in 1975.

Comparing the R & D expenditure as a percent of National Income in Japan with those of other countries, we see that Germany tops the list with 2.61% in 1976, followed by the U.S.A. with the 2.47% in the same year and the U.K. with 2.26% in 1972. But the figures of these countries include funds for armament research, while that of Japan does not. In Japan the defense budget has always been less than 1% of GNP, since Japan's Constitution does not permit rearmament.<sup>6)</sup>

As the above figures indicate, the R & D in Japan has developed rapidly, but this fact does not tell us how much progress it has made, particularly not how much original technology was developed. Although there have been many innovations and discoveries in the various fields of technology such as the NT compound metal, TICUT a cutting tool, magnetic material, high polymer, semi conductive polymer etc., these innovations and discoveries remain very few as compared with those of Western countries.<sup>7)</sup> To be sure, comparing levels of different kinds of technology is very difficult, but we might be able to roughly estimate their importance by enumerating innovations, patents, theses, Nobel prizes and so on. Thus, using the index of the technological level as pointed out by the Science and Technology Agency of the Japanese Government, which itself is calculated on the basis of four indices: (a) the number of patent registrations, (b) the amount of technological trade, (c) the amount of value added, (d) the total export of technology intensive products, we can assess Japan's level of technological development on the basis of the following indicators: (1) The above mentioned level of technology. (2) The total amount of manpower and funds invested in R & D. (3) The amount of export of technology and the number of patents acquired abroad. Then, if Japan's level of technological development can be indicated by the combination of 1, 2 and 3, Japan and other countries compare as follows. Taking 100 as the index number of the U. S. A. in 1968, West Germany amounted to 27.0, France to 17.1, the U. K. to 17.4 and Japan to 14.6.

6) Indicators of Science and Technology, Science and Technology Agency, 1978, p. 3.

7) Nippon no Jishu Gijitsu, (Original Technology in Japan) ed. Kagaku Gijitsu to Keizai no Kai (Japan Techno-Economics Society) 1979.

However, in the first half of the 1970's West Germany rose to 35.6, France to 23.4, the U. K. to 18.6, but Japan rose to 30.0.<sup>8)</sup> As this rise in index shows, Japan's technological level certainly has increased, but again, this does not necessarily indicate the extent or ability to develop and original, indigenous technology.

Considering the ratio of balance of technological trade, earnings surpass expenditures. Japan's rates are as follows: 0.01 in 1955, 0.10 in 1965 and 0.23 in 1975. But in 1975 the ratio of the U.S.A. was 9.9, that of West Germany 0.37 and that of France 1.29. From this we can conclude that Japan's level in this respect is rather low, since its ratio is that small.<sup>9)</sup>

##### 5. Reasons for limited progress

As a matter of course, there are political, economical and many other reasons why R & D could not develop better in Japan, but in this limited perspective I would like to consider mainly the sociocultural factors involved, seen from a sociological stand-point.

One of the reasons that can be pointed out is the long history itself of importing science and technology after the Meiji Era. In order to make smooth progress, the government regarded importation and imitation of foreign technology as the most efficient policy. In the same way, business leaders saw the import of technology as the shortest way to success. Thus government and business alike fell short of encouraging an original, indigenous technology.

The next factor in limiting progress probably is the homogeneity of Japanese society

8) White Paper of Science and Technology, 1977, pp. 288-289.

9) *ibid.*, 1976, p. 326.

and culture. We Japanese, being a people of the same stock, speak the same language and have identical social customs. It can be said that a common identity and cultural homogeneity function as limiting creativity. This consideration is related to the theory of "marginality" as one of the conditions for the creation of new ideas. In Japan neither marginal culture nor a marginal man have existed to any notable extent. As G. Simmel has pointed out, a marginal man usually enjoys more freedom and objectivity. He is less tied down in his actions by habit, piety and precedent.<sup>10)</sup> Since Japanese culture has not provided any marginal situations, Japanese people are less stimulated to think in new ways or to take different standpoints, and were therefore slow in innovating or creating a new technology.

A third reason is the particular character of education in our country. Universities break up into sharply divided faculties, which have hardly any contact with one another. Moreover, the faculty is usually divided into a few sub-faculties staffed by a professor, an assistant professor, a few lecturers and assistants, the latter without teaching qualifications. As faculties in technology departments have no close contact with one another, research tends to be isolated and is apt to stagnate. The purpose of a sub-faculty seems to be maintaining itself rather than doing research.

Further, we must refer to the entrance examinations of all schools, especially of universities, which are commonly referred to as the "examination hell". Most education in junior and senior high school is devoted to preparing these examinations, not to learning itself. Under such conditions most of the

students, also those of technology and related subjects, get the tendency of learning by heart and relying on their memory instead of developing attitudes of personal discernment and creative thought. They may be skilful in combining, reforming and improving but not in creating something new.<sup>11)</sup>

One more reason can be found in the indigenous organization of R & D in Japan. Generally stated, Japanese organizations have management systems of their own, which show traditional features but also highly modernized ones. The former are related to life-employment in the same organization, almost regardless of performance. The latter are related to the wage system determined by seniority and promotion according to length of service. This system as a whole was very effective in preventing labor turnover and strengthening the sense of belonging and identification with the organization, but was not conducive to the creation of new knowledge or technology. Close relationships between researchers and loyalty towards the boss tend to hinder sound competition and to keep sources of new ideas closed. Of course, after the second World War, Japanese organizations have changed little by little. Especially at the stage of high economic growth, the modernization of the management system progressed more systematically by introducing the newest techniques developed in the U.S.A.. Notwithstanding this, the traditional aspects of Japanese systems have persisted till today.

## 6. Summary and Future Perspectives

It can be said that R & D made Japan's postwar "economic miracle" possible. But most of this R & D in our country was

10) G. Simmel *Soziologie*, Fünfte Auflage, SS. 510-511.

11) For details, cf. my article "Technical Education in Japan".

imported from the West. In spite of the increase in number of researchers and the amount of funds, research here has made slow progress as compared with other advanced countries.

To make more steady progress, it seems important not only to enlarge quantity by increasing manpower, funds, equipment and facilities, but especially important is the improvement of quality by ameliorating education and reconstructing the relationships between organizations and researchers. To develop R & D creatively, we must continue to rationalize our management systems while making the best use possible of our own traditions. However, as regards the future, I am inclined to think that pure indigenous and creative types of technology, as described

above, have not many chances to develop. The imported type can not prosper either, because of the stagnant situation of innovation around the world. Thus we must conclude that the improved type of technology remains the most suitable type for R & D in Japan, especially since this type, which results from the transfer, combination and improvement of domestic and introduced technology, was the most familiar method of development since the Meiji Era. Also, it may produce results that minimize the risks involved in advanced technology.

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