The Way Japan Joined Mechanized Civilization

SENRI ETHNOLOGICAL STUDIES No. 46 1998

The Way Japan Joined Mechanized Civilization

TAKAMATSU Toru
Osaka University of Economics

1. PERRY'S PREDICTION

Commodore Perry, whose visit to Japan during the waning years of the Edo period ended more than two centuries of relative isolation, wrote as follows about Japanese technology in his official report [HAWKS 1856: 455]:

> In the practical and mechanical arts, the Japanese show great dexterity. ...Once possessed of the acquisitions of the past and present of the civilized world, the Japanese would enter as powerful competitors in the race for mechanical success in the future.

This prediction hit the mark admirably. Yet while Perry may have had fine insight, it is necessary to give fresh consideration to Japan's technological strength at the time, and to the excessively low appraisal that the Japanese has nonethless sustained on their own technology.

However outstanding its technology may have been at the close of the Edo period, the fact is that Japan did not have at hand all of the technical elements necessary for the construction of a mechanized civilization. Perry saw only the technical intricacies of such traditional industries as shipbuilding and spinning. It is apparent that various problems had to be resolved in order to acquire modern technology. Moreover, even if the gap between Japan and the West had been small, it would not necessarily have guaranteed future growth. For if the West had developed technology faster than Japan was catching up, the gap would only have widened. That problem had to be solved during the process of modernization which followed. Through an investigation of the extent to which Perry's

prediction was realized, let us reevaluate the conditions through which "mechanical success" was achieved during the Meiji and Taisho periods. [1)]

2. RELIANCE ON IMPORTED TECHNOLOGY: DOES THE THEORY STAND UP?

Up to now, the ways in which Japan coped technologically with the environment of change when the country was reopened have been described mainly within a scheme of antagonistic relations with the West. According to that scheme, on one hand all sorts of modern goods flowed in from Europe and America and squeezed the traditional industries, and on the other hand, industrialization was accomplished through the production of modern goods using machinery imported from the West.

The spinning industry serves as the typical example to support this formulation. The Osaka Spinning Mill, which began operating in 1883, adopted the form of a Western-style joint-stock company, installed British-made spinning machines, used a British-made steam engine for motive power, and moreover, carried out operations on the basis of technical training at a British factory. As early as 1886, it went on to inaugurate electric lighting, using an American-made electrical generator. [KINUGAWA 1937: 394–397, 403–410] Following the success of the Osaka Spinning Mill, a series of other spinning companies were likewise established by introducing British machines, and the spinning industry became the point of departure for Japan's industrial revolution. Afterward, reliance on imported spinning machines continued for some 40 years until the 1920s, supporting the growth of the industry that was the pivot of Japan's modern industry.

Japan's modern spinning industry was indeed established by gathering the best imported technology available. Taking the case of the spinning industry as the model, the notion has been fabricated that the industrialization of Japan was carried out through reliance on imported machinery. But was the spinning industry truly the model for the industrialization of Japan?

If it is the case, as seen in the spinning industry, that the establishment of modern industry in Japan relied upon imported machinery, then it must naturally

---

1) Machinery is valid as the topic for discussion in that: [1] machinery manufacture may be taken as a provisional index of technological attainment because most modern technologies developed hand in hand with mechanical progress; [2] machinery imports are a valid means of confirming the process of Japan's acquisition of modern technology because they are regarded as the main channel of technology transfer from the Meiji period onward [e.g. UCHIDA 1990: 282–286]; and [3] the machinery industry presents favorable data for reassessing Japan's technical strength at the time because, whereas it has conventionally been said to symbolize Japan's technological backwardness [e.g. TOYOSAKI 1941: 25–44], it has today become the driving force of prosperity.

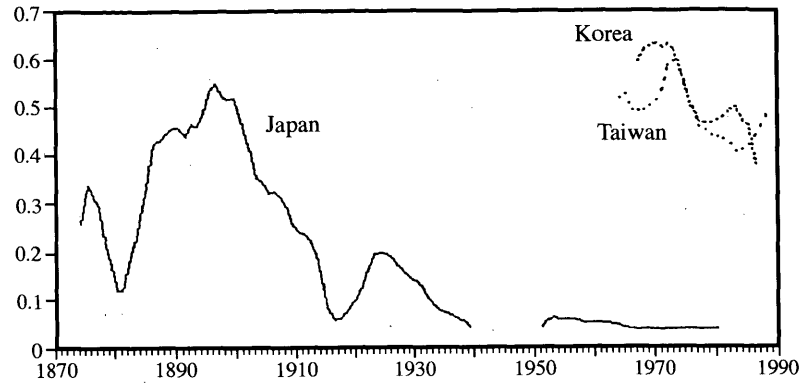

Figure 1. Degree of Import Reliance in Industrial Machinery for Japan, Korea and Taiwan

Calculations from data in:
For Japan: Shinohara, *Choki keizai tokei 10* (*Kokogyo*) [Long-term Economic Statistics 10 (Mining)], Toyo Keizai Shimposha, 1972; Yamazawa and Yamamoto, *Choki keizai tokei 14* (*boeki to kokusai bungyo*) Long-term Economic Statistics 14 (Trade and the International Division of Labor)] Toyo Keizai Shimposha, 1972; Yamazawa, *Nihon no keizai hatten to kokusai bungyo* [Japanese Economic Development and the International Division of Labor], Toyo Keizai Shimposha, 1984. For Korea: United Nations, *Yearbook of Industrial Statistics*; Korea Machine Industry Promotional Association, *Machine Industry Handbook*. For Taiwan: *Statistical Yearbook of Chinese Trade Advances* (*Taiwan District*); Republic of China/Taiwan Industrial Production Statistics Monthly Reports.

NOTE: 5-year running averages

be true that the proportion of domestic demand for machinery that was filled by imports (the degree of import reliance) would have increased along with the full-scale industrialization of Japan from 1900. Yet the reality is precisely the opposite (Figure 1). Although rough figures have been used, it is clear that the degree of import reliance rose from the early Meiji years, peaked in the 1890s, and actually fell rapidly even though industrialization was proceeding apace. Of course imports continued to increase, but they were outstripped by domestic machinery production.

By comparing that transition to the experience of present-day Korea and Taiwan, both of which have maintained degrees of import reliance of about 50%, the speed with which domestic machinery production advanced in Japan becomes clear. On the basis of these facts, we must reject the simple theory of reliance on imported technology which claims that Japan accomplished its industrialization on the basis of imported machinery.

3. NICHE SEGREGATION OF MACHINERY

When we look at the principal types of machinery imports up to 1900, the first

thing that draws attention is that they were not introduced in a manner that crowded out existing technology. Obviously, railroads and telegraphs were entirely new types of machinery. Yet it was the development of traditional industries which that type of machinery served, as with the furnishing of national markets for the silk and textile industries through low-cost rail transport. It is further worth notice that many other types of machinery which may be thought to have rivaled existing technologies also in fact did not compete directly with traditional industries, but instead built up new fields of industry.

The clearest example is the marine transport industry. The majority of imported vessels were steamers that were deployed on ocean routes for purposes of trade. It goes without saying that this industry was subject to self-imposed limits during the national seclusion of the Edo period. Meanwhile, on coastal routes, conventional Japanese-style wooden ships and their improved versions, known as "crossbreed ships," were used and prosperity continued.

There was similar niche segregation of machinery in most other industries as well. In the cotton textile industry, imported power broadlooms (wider than 36 cm) were installed in the cheaply run cloth factories attached to the spinning mills, engendering the manufacture of Western-style clothing for export. Japanese-style clothing for the domestic market was woven on narrow (36 cm) handlooms as an auxiliary occupation of farm families. In the paper industry, imported machinery was used to produce the Western-type paper used for newspapers and magazines. Meanwhile, there was continued growth in the manufacture by conventional techniques of traditional handmade Japanese paper suitable for brush writing, sliding *shoji* doors and the like. In the flour industry, imported milling machinery was used mainly to produce ingredients for bread and Western-style cakes, while the indigenous mills using water wheels and stone mortars made the "udon flour" used in wheat noodles such as *udon* and *somen*. As was the case with foreign trade, bread or Western-style clothing and paper were new commodities for which demand first began in the Meiji period.

Imported machinery and indigenous machinery cannot be discussed solely in terms of high-productivity modern machinery and low-productivity traditional machinery. By fulfilling technical requirements that applied to various products (or industries), various machines became established in their respective niches. For example, even in the case of wheat flour, where we might expect only minimal difference between modern and traditional products, the "American flour" from roller mills and the "udon flour" from water-powered mortar mills were treated as different products. In mortar-milled flour, the cortical layer of the wheat is also ground up and mixed in, because without its high protein content, the indigenous flour is so low in protein that the noodles will not become sticky. For breadmaking, on the contrary, use of the cortical layer has to be avoided. Therefore, to produce flour suitable for bread, the wheat is roughly ground with grooved rollers, then sifted, and finally pulverized with smooth rollers [NAKAJIMA 1967: 4–5]. Each civilization had developed its own technologies to correspond to

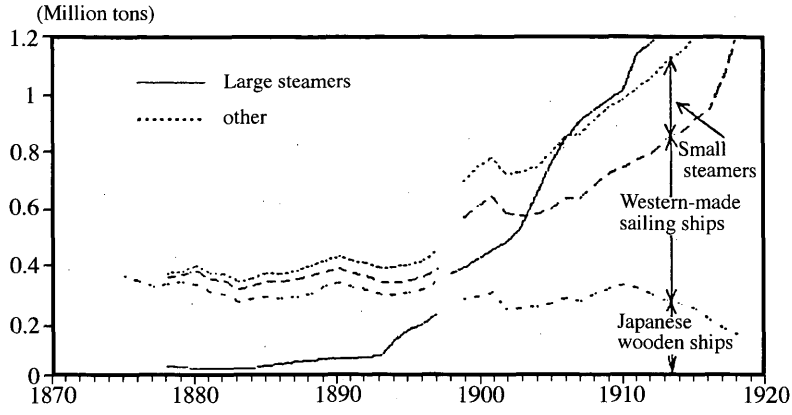

Figure 2. Constituency of the Maritime Fleet

Source: Naikaku Tokeikyoku, *Nippon teikoku tokei nenkan* [Statistical Yearbook of the Japanese Empire], various years.

NOTE: The survey method changed from registered tonnage up to 1897, to gross tonnage from 1898. Vessels exceeding 500 registered tons up to 1897 are taken as 1000 gross tons from 1898.

its patterns of materials and consumption.

It should be emphasized that imported machinery existed in newly generated product fields, and was not brought in as a superior replacement for native technology.

4. INCOMPATIBILITY OF IMPORTED TECHNOLOGY

Furthermore, most of the modern industries that did utilize imported machinery remained sluggish until about 1900. Coastal maritime routes were monopolized by sailing ships, especially Japanese-style wooden ships, and since foreign trade had not yet developed, there were limits on the development of ocean-going vessels (Figure 2). In manufacturing industries as well, until full-scale growth commenced in the first decade after 1900, the imported machinery was simply too much for them to handle. In the paper industry, for example at the Yukosha Company which was founded in 1874, for some three years virtually none of the products could be sold. A total of six papermaking machines were imported to Japan by 1876, but none at all were imported during the ensuing twelve years [Oji Seishi 1937: 291–292, 467–468].

Imported machinery involved problems in the area of operating technology, but there was the prior problem of limited demand for products that the machines could make. From 1885 through 1900, the increase in value of Western-type paper production was only half, and of imports just one third, of the amount of increase in value of Japanese paper production [2]. Modern products, far from crushing

traditional industries, were on the contrary overwhelmed by them. The machinery that flowed in with the opening of the country did not in itself result in the development of modern industry.

The spinning industry which did promptly develop through machinery imports was an exception. The reason why the modern spinning industry outpaced other industries and began growing in the 1880s was that in this case there was exceptionally direct competition between imported and native products. Demand for cotton thread in Japan was for heavy thread to be used in weaving thick cotton *kimonos*. Importation of the fine thread from Great Britain was checked, reflecting, as with other products, differing consumption patterns. However, heavy thread produced in India with British spinning machines did prove competitive against native products [KAWAKATSU 1991: 76–80]. Through that rivalry, that is, on the premise of the existence of demand for modern products, a modern industry based on imported machinery could promptly be launched.

That sort of intra-Asian competition is hardly found among the other chief industrial products. When we realize that the other industrial products imported from Europe and America were not able easily to topple the barrier of native products, it becomes clear that the spinning industry, while it was the starting point of Japan's industrial revolution, was atypical. Clearly, it is necessary to revise the theory of reliance on imported technology, which uses the spinning industry as its representative case.

Prior to 1900, domestic production of machinery was hardly invigorated. As a result, the degree of import reliance did indeed rise through the influx of machinery. During the time when imported machinery was not allowed space for activation in most industries, domestic machinery production naturally did not advance. The rise in the degree of import reliance may well have reflected the excessive expectations with which Japan greeted modern technology during the Meiji period. At the same time it furnishes concrete proof that, in Japan's case, the simple importation of machinery was not sufficient to support the development of industry.

We may go on to note that the phase of transplanted technology is something that occurs in developing countries everywhere. Restraint of transplanted modern technology by traditional industries was also seen in its time in China, and today is a major factor in the derailing of development policies in developing countries. The differences are confirmed in the ensuing process of full-fledged industrialization.

---

2) The values of Japanese-type paper production, Western-type paper production, and Western paper imports, respectively, in 1885 were 2,137,000 yen, 3,000 yen and 88,000 yen; and in 1900 were 13,985,000 yen, 7,000,000 yen and 3,833,000 yen. [TOYO KEIZAI SHINPOSHA 1975: 260–264; TSUSHO SANGYO DAIJIN KANBO CHOSA TOKEIBU 1979: 416–418]

5. FORMATION OF MODERN INDUSTRY ENABLED BY MATERIALS IMPORTS

If the formation of modern industry was not decisively triggered by the import of products and technologies from the West, what might have served as the driving force for modernization?

Up to now we have thought of the opening of Japan in terms of contact with the West, and we have been obsessed by comparison and rivalry with the West. Throughout Asia, from the latter half of the 19th century through World War I, that is, during the period when Western imperialism was most relentlessly on the march, development occurred less in the area of East-West trade—read import of Western industrial goods and export of Asian raw materials—than in intra-Asian trade [SUGIHARA 1985: 17–27]. This fact demands attention. The opening, or colonization, of Asia by the West was not merely a mechanism of plunder, but also served as an opportunity for reorganizing the division of labor within Asia.

In each of the industries that were discussed above, the expansion of trading spheres, especially trade with Asia, served to bring modernization into full stride. In marine transport, it is obvious that the development of transoceanic shipping depended on the expansion of trade. Asia accounted for no more than 20% of Japanese foreign trade in the early Meiji years, but the proportion grew along with the development of trade, rising to about half of the total in 1920 [3]. Growth in intra-Asian trade was the nucleus for the development of the maritime industry.

In manufacturing, modern industrial development was made possible by changes in raw materials that were in turn made possible by the expansion of trading spheres. Even the spinning industry, which did not bump up against the barriers of consumption patterns, relied on cotton imported from China and India (and America). In the modern paper industry, large-scale production could not be attained with the resources available on Honshu (spruce and hemlock), and the use of pulp wood from Hokkaido and Sakhalin (Ezo spruce and todomatsu fir) proved to be the necessary for full development [SUZUKI 1967: 144]. In the flour industry (Figure 3), mechanized mills could not hold their own against the water-powered mortar mills as long as highly dispersive domestic wheat was used, but they began to grow with the use of imported wheat from America and China. Their product even displaced mortar-milled flour as the material for udon and other noodles.

Under the existing materials structure, modern industry was squeezed by traditional industry and at length secured niches in the area of new commodities. Then through changes in the materials structure, it obtained profits through mass

3) Yen values of trade and of trade with Asia, excluding shipments to and from the colonies of Taiwan and Korea: 1880 exports 28,395,000 (including 6,551,000 to Asia), 1880 imports 36,627,000 (including 7,606,000 from Asia), 1920 exports 1,948,395,000 (including 998,374,000 to Asia), 1920 imports 2,336,175,000 (including 942,547,000 from Asia). [TOYO KEIZAI SHINPOSHA 1975: 349–368]

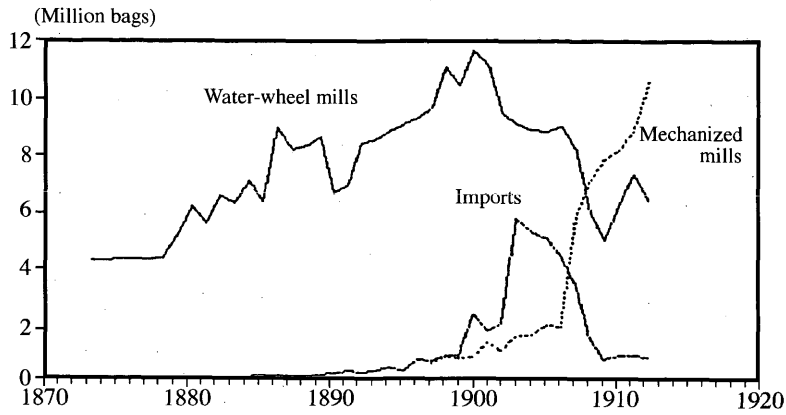

Figure 3. Wheat Flour Supply by Source

Calculations based on data from: Mizuno, *Nippon komugi no keizaiteki kenkyu* [Economic Studies of Wheat in Japan], Senso Shobo 1944; Nippon Kogakkai, *Meiji kogyoshi (kikaihen)* [Meiji Industrial History (Machinery)], 1930.

NOTE: One bag is about 22 kg.

production, broke down the niche segregation, and grew while superseding traditional industries. The decisive opportunity for the establishment of modern industry was provided not by the import of technology from the West, but by the removal of the limitations of the previous materials structure.

6. MODERNIZATION THROUGH DOMESTICALLY PRODUCED MACHINERY

Another important point is that once full-fledged modern industrial development did begin, domestically produced machinery was deployed and became the main force for growth. Rapid expansion of trade occurred from about 1900, and by 1910 more than half of the newly built ships deployed on ocean routes were domestically produced. Imported ships still comprised the majority of the fleets, but most of them were the used vessels which had been in service for at least 15 years [4]. Reliance on imported vessels reflected not a difference in shipbuilding capabilities, but only a difference in the history of the modern shipbuilding industry. On coastal routes, domestically built steamers were introduced and gradually replaced sailing ships.

---

4) In 1910, in the commercial fleet (steamers of at least 1,000 tons gross) of 338 ships (995,393 gross tons), domestically manufactured ships numbered only 66 (255,312 gross tons), but among those less than 15 years old, of a total of 121 ships (461,903 gross tons), domestically manufactured ships numbered 65 (253,752 gross tons). Calculated from data in [TEISHINSHO 1912: 16–17].

It is the same with manufacturing. By World War I, modern industry had grown to a scale comparable to traditional industry, and domestic production of modern machinery had commenced. Toyoda succeeded in fabricating broadlooms from iron and steel in 1908. Their performance was no different from that of the competing British looms, and they were soon deployed in the production of cotton cloth for export [TOYODA JIDO SHOKKI SEISAKUSHO 1967: 52]. The firm later leaped beyond the textile machinery business into automobile manufacturing. With other machinery for manufacturing use, domestic production grew greatly during World War I. During the stage of the full-fledged development of modern industrialization, it was not imported machinery but domestic machinery which multiplied.

It is true that imports of machinery continued to increase thereafter. Since Western modern technology was more advanced, imports transpired whenever demand for new machinery rose along with industrialization. As a result of these machinery imports, Japan seems to have been overly concerned with its reliance on imported machinery and to have nurtured an excessive sense of inferiority toward Western technology. However, the causes of that should be sought in Japan's very rapid industrialization, and there is no need to point out the greater-than-necessary reliance on imported technology [TAKAMATSU 1990: 36–41].

Where the problem lies is in how it was possible to display such a superb accommodation on technology. Up to now, it has been held that Japan made up for its deficiency in technology through imitation. Certainly imitation occurred. Yet it was not possible unconditionally. Imitative production of machinery cannot be done simply by disassembling the machines and making design drawings. During the infancy of the machinery industry, to begin with, engineering techniques were insufficient. Furthermore, suitable materials could not be obtained. It was totally impossible to produce machines according to design drawings [e.g. TOKYO ISHIKAWAJIMA ZOSENSHO 1930: 206, 230]. Moving step by step toward the prescribed performance, while keeping in mind the balance between quality of materials and precision of workmanship, is a process that brings together and combines many elements, and demands the same technical abilities required for the development of new machinery. At the very least, it is necessary to draw a clear distinction between that and the presently flourishing fabrication of counterfeit brand-name goods and imitation auto parts.

If we trace machine manufacturing technology to its origin, we may mention the existence of traditional technology for casting, or the diffusion of technology from Edo-era shipyards. Yet production was not made possible simply through the conditions of the suppliers of that kind of technology. Unlike imitation parts, for a machine that is basically produced to fill an order, if the equipment and materials are insufficient, not only will the capacity drop, the time required for production will push the price higher than that of a Western-made machine [e.g. KOGYO ZASSHI SHASETSU 1898:513, NIPPON SANGYO KIKAI KOGYOKAI 1965:84–85]. In the area of modern machinery where there was supposedly direct competition with the West,

how was this problem disposed of?

Even aside from ships and railroads, no special protective policies were enacted for manufacturing machinery. Appealing for patriotic support of domestically made goods or using connections to obtain orders were important techniques, but those alone could not sustain competition with Western-made machinery.

7. TRADITIONAL INDUSTRY AS THE WIDWIFE OF MODERN TECHNOLOGY

Actually, in this area also, competition with Western-made machinery did not present a major problem. For example, small vessels for coastal maritime routes, regardless of their transportation machinery, were exceedingly troublesome machines for long distance transport. They incurred expenses for towing, and were highly hazardous. On that point, in Japan there was a geographical import barrier. The construction of iron and steel ships in Japan began from their introduction on coastal routes, mainly in the Inland Sea where sailing ships had flourished [NIPPON KOGAKKAI 1925: 167–173].

With machinery for manufacturing as well, in the securing of business opportunities in traditional industries, competition with Western-made machinery was avoided. A good example would be Toyoda's commencement of production with narrow wooden power looms. Narrow looms were characteristic of the Japanese-style clothing industry, and hence were weak in terms of competition with imported machinery. Moreover, they could be accommodated by wooden frames which could be produced by making use of traditional woodworking technology [NAKAOKA 1986: 92–93]. Even in the electric power industry where it might seem that there was no traditional industry to be supplanted, the point of departure for the electrical equipment makers was the furnishing of small hydraulic generators to replace water wheels as the source of driving power in farming villages [OTAKE 1931: 40–50]. The problem was not so much competing with imported machinery but opening up the market. The electrical equipment makers had to assist opening plans for prospective users who were not accustomed to employing machinery, and sometimes launched power industry by themselves [KAWASAKI ZOSENSHO 1936: 6–7, TOKYO ISHIKAWAJIMA ZOSENSHO 1930: 194–197, TOKYO SHIBAURA DENKI 1940: 51]. It goes without saying that the introduction of modern machinery into traditional industries furnished business opportunities for the machinery industry, and at the same time stimulated the development of the traditional industries.

Technology can only be acquired experientially. This is true equally for traditional technology and for the production and design involved in modern technology. Obtaining business opportunities is necessary not only to exist as a producer, but also to acquire technology [NAKAOKA 1990: 16–24]. The traditional industries, which formed markets that were geographically and culturally exclusionary toward imported machinery, finding themselves at the point of taking in modern machinery, offered points of contact for makers who were in their

infancy but could somehow produce, and thus acted as incubators for development. This has great significance. While storing up a certain degree of technology in those nurseries, it was possible to enter the field of modern machinery and compete with the West. Then when imports were interrupted during World War I, the industry grew at a stroke to the point of being able to make competitive machinery.

In China as well, as one link in the Westernization Movement, large-cale government-operated machinery factories were established one after another from 1865. As in Japan, machinery fabrication techniques were studied under the tutelage of foreigners in government employ, and steamship building and other operations were conducted [Wu 1978: 338–359]. For example, the Jiangnan Manufacturing Bureau grew to some 3000 workers, exceeding the 1885 levels of 2500 at Yokosuka Naval Shipyard, or 500 at the Nagasaki Shipyard [Naikaku Tokeikyoku 1886: 153–154].

One reason why technology from government-operated factories was not linked up with fabrication of manufacturing machinery might be the problem of business opportunities in traditional industries. The Chinese textile industry, for example, in the main continued to use old-fashioned hand looms. Finally, in the early 20th century, the "Baton" equipped with a flying shuttle was brought in from Japan and began to spread. Power looms worthy of being called modern machinery hardly spread at all [Hatano 1961: 529–553]. China's farm-village industries, where the commodity economy did not penetrate, offered scant opportunity for the modern machine industry to do business.

8. THE TECHNOLOGICAL STRENGTH OF CIVILIZATIONS

As we have seen thus far, the process by which Japan joined mechanized civilization did not, as has previously been claimed, unfold around a pivot of reliance upon, or of competition with European and American technology. Instead, it was a process that was very much independent of the West, involving the mutual complementary action of modern technology in promoting the development of traditional technology, and traditional industry fostering modern technology.

That sort of technological chain, which operated as an entire system by a given civilization, and the arrangement of technologies which makes that possible, are the crucial elements to consider in thinking about the technology of that civilization. We may also say that the development of particular technologies is the result of the technological strength displayed by that civilization in general. Japan, through an impressive display of such technological strength, found its opportunities for technological development mainly within its borders, and created a technological system with a high degree of perfection.

When Japan's self-reliant process of technological development is compared to today's newly industrialized economies (NIEs) such as Korea and Taiwan, we find definite differences with respect to the position of technology. Those countries have used exports as the driving force to stimulate industrialization. In Korea's

case, the proportion of production occupied by exports reaches 50% for passenger cars and two-thirds for electronic equipment. When markets are sought abroad (especially in developed countries), the products are naturally required to meet global standards of price and quality. In order to compensate for lack of the necessary technology, there is no choice except to rely on imports from developed countries. That shows up as the high degree of import reliance in machinery that was observed above. Yet the reliance on imported technology in Korea and Taiwan does not reflect merely technological backwardness compared to Japan. We must look more closely at the qualitative differences.

Export-led industrialization is propelled through the realization of a global "mechanized civilization." The development of machinery, through raising the technology embodied in the machine to a high standard, also raises the contents of technology transfer to a high standard. Of course, certain conditions must be provided, but there is no doubt that the transfer of technology among nations is thus activated. One example, in the high-technology area of semiconductors, would be Korea's success in 1988, only two years behind Japan, in producing the one-megabyte DRAM [FUKAGAWA 1989: 222–235].

The development of durable consumer goods, which is assembled from a large number of parts, disperses the production sites for parts production and assembly around the world. For example, Japanese electronic equipment makers have gone all over the world for parts and product manufacturing, with the number of overseas firms serving as production sites reaching 840 in 1991 [NIPPON DENSHI KIKAI KOGYOKAI 1991: 1]. The technological attainments of the NIEs assume as a premise the formation of such a global "mechanized civilization" in the context of the international division of labor.

It is no exaggeration to speak of a basic contrast between Japan, which built up a mechanized civilization within its own borders, and the NIEs who have developed their industries within a global "mechanized civilization." At the least, the technological chain today is not comprised of national units, but operates on a global scale. As a result, it is difficult now to take the route that Japan took, of developing its own technology while restraining machinery imports by way of a primarily domestic technological chain.

It is neither easy nor efficient for the NIEs, having already been exposed to world-level technology, to reach a high degree of technological perfection in a purely domestic setting. Obviously, this evolution of the international division of labor is not a phenomenon that is limited to the NIEs. A worldwide system, including Japan, of mutual technological reliance is presently being constructed.

Amid this situation, it might be Japan who, as an extension of her technological development up to now, is poised to maintain a technological system with a high degree of perfection. The present prosperity of mechanized civilization has already begun to corroborate that prediction. A comparison with Europe and America, in terms of the modes of relation to the system of the international division of labor, is a very interesting topic for investigation, although space does

not permit its discussion here. However, it is also true that, amid the deepening of the relationships of mutual reliance, prosperity in isolation will not be possible forever.

In the future, how should Japan, having displayed a impressive capacity based on an internally constructed technological system with a high degree of perfection, contrive to adapt herself to a global "mechanized civilization"? What type of technological capacity should Japan, having thus far fervently amassed its technology amid an excessive sense of inferiority toward the technology of the West, manifest in connection with world development? These questions are as important as the prospects of high-technology in due consideration of Japan's technical capabilities in the 21st century.

BIBLIOGRAPHY

FUKAGAWA, Yukiko (深川由紀子)
1989 『韓国—ある産業発展の軌跡』日本貿易振興会。
HATANO, Zenta (波多野善太)
1961 『中国近代工業史の研究』東洋史研究会。
HAWKS, Francis L.
1856 *Narrative of the Expedition of an American Squadron to the China Seas and Japan*. Washington: A.O.P. Nicholson.
KAWAKATSU, Heita (川勝平太)
1991 『日本文明と近代西洋』日本放送出版協会。
KAWASAKI ZOSENSHO (ed.) (川崎造船所編)
1936 『川崎造船所四十年史』。
KINUGAWA, Taichi (絹川太一)
1937 『本邦綿絲紡績史 (第二巻)』日本綿業倶楽部。
KOGYO ZASSHI SHASETSU (工業雑誌社説)
1898 「工業界の観察」『工業雑誌』8 (150):513–517。
NAIKAKU TOKEIKYOKU (ed.) (内閣統計局編)
1886 『日本帝国統計年鑑 (第 5 回)』東京統計協会。
NAKAJIMA, Tsuneo (中島常雄)
1967 『現代日本産業発達史 18 (食品)』交詢社。
NAKAOKA, Tetsuro (中岡哲郎)
1986 「技術史の視点から見た日本の経験」中岡哲郎, 石井正, 内田星美編『近代日本の技術と技術政策』国際連合大学, pp. 3–106。
1990 「技術形成の国際比較のために」中岡哲郎編『技術形成の国際比較』筑摩書房, pp. 4–32。
NIPPON DENSHI KIKAI KOGYOKAI (ed.) (日本電子機械工業会編)
1991 『海外法人リスト (1991)』。
NIPPON KOGAKKAI (ed.) (日本工学会編)
1925 『明治工業史 (造船篇)』明治工業史発行所。
NIPPON SANGYO KIKAI KOGYOKAI (ed.) (日本産業機械工業会編)
1965 『産業機械工業発展過程』。
OJI SEISHI (ed.) (王子製紙編)
1937 『日本紙業総覧 (昭和 12 年版)』。

OTAKE, BUKICHI (大竹武吉)
1931 『工学博士岸敬二郎伝』岸敬二郎君伝記編纂会。
SUGIHARA, Kaoru (杉原薫)
1986 「アジア間貿易の形成と構造」『社会経済史学』51(1):17–53。
SUZUKI, Hisao (鈴木尚夫)
1967 『現代日本産業発達史・12 (紙・パルプ)』交詢社。
TAKAMATSU, Toru (高松亨)
1990 「中進国機械貿易の発展」中岡哲郎編『技術形成の国際比較』筑摩書房，pp. 33–56。
TEISHINSHO (ed.) (逓信省編)
1912 『海事統計類纂 (明治 45 年)』。
TOKYO ISHIKAWAJIMA ZOSENSHO (ed.) (東京石川島造船所編)
1939 『東京石川島造船所五十年史』。
TOKYO SHIBAURA DENKI (ed.) (東京芝浦電気編)
1940 『芝浦製作所六十年史』。
TOYO KEIZAI SHINPOSHA (ed.) (東洋経済新報社編)
1975 『日本貿易精覧 (復刻版)』東洋経済新報社。
TOYODA JIDO SHOKKI SEISAKUSHO (ed.) (豊田自動織機製作所編)
1967 『四十年史』。
TOYOSAKI, Minoru (豊崎稔)
1941 『日本機械工業の基礎構造』日本評論社。
TSUSHO SANGYO DAIJIN KANBO CHOSA TOKEIBU (ed.) (通商産業大臣官房調査統計部編)
1979 『工業統計 50 年史 (復刻版)・2 巻』龍渓書舎。
UCHIDA, Hoshimi (内田星美)
1990 「技術移転」西川俊作，阿部武司編『日本経済史 4—産業化の時代 (上)』岩波書店，pp. 256–302。
WU, Jie (呉杰)
1978 『中国近代経済史』大塚恒雄，陳 継昌訳 角川書店。