TRADITIONAL TECHNOLOGY AND ITS IMPACT ON JAPAN'S INDUSTRY DURING THE EARLY PERIOD OF THE INDUSTRIAL REVOLUTION

By ERICH PAUER

1. Introduction

Domestic technology is usually connected with the economic environment, including raw materials and working conditions. Imitation is an important factor in importing advanced foreign technology. The standing of indigenous technology and the level of skills, tools or machines used by the craftsmen are to a certain extent responsible for the successful start or the failure of western-style industrialization.

It is in this context that in the last few years renewed attention has been paid to the Japanese example. It is now widely recognised that Japan's successful industrialization must be traced back to the high level of indigenous technology, accompanied by such other elements as a high rate of literacy and well established commercial, financial, fiscal, administrative, and other structures.

Can we infer that Japan's industrialization was based on her craft skills? If we look back further than the 19th century this conclusion seems rather doubtful. The first Westerners arrived in Japan in the 16th century and introduced Western techniques such as clock-making, printing and casting. The Japanese were then already well acquainted with the mechanical shifting of gears, and craftsmen could make moving and fitting parts. But there were deficiencies. We can give a number of examples of indigenous skills meeting with limitations. However, the technicians needed to copy or duplicate relatively complicated tools had reached a high level by the early 19th century. Around 1850, when Japan was confronted with the early forerunners of the coming industrial revolution, this kind of knowledge and skill was already widespread, and there existed a class of highly skilled artisans.

2. Japan's “Industrial Revolution” and the period of “Industrial Apprenticeship”

The Japanese Industrial Revolution in its narrow sense usually refers to the mid-1880s. Such a narrow definition of the industrial revolution is based on quantitative records, figures and statistics. A broader view of economic and technological development has emerged in recent years however, and now we tend to regard industrial revolution as a process covering a longer period.

In such an approach qualitative rather than quantitative modifications are important factors in the industrial revolution in Japan between 1850 and 1920. These changes include innovations in
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industrial organization, the institution of the factory system, and the use of new technology. Proto-industrialization is characterized by a shift to non-agricultural activities where production is carried out in a labour-intensive process. The industrial revolution is characterized by the transition from indigenous to "modern industry" which is capital intensive, energy consuming and based on the burgeoning factory system. The industrial revolution in Japan (as elsewhere) meant a revolution in organization and technology. This means we must emphasize the change-over from crafts to industrial production when we study the history of technology in Japan.

Qualitative change or modifications must be identified based on verifiable features. This features are

1) a "factory"-like organizational structure of production based on mechanized processes that differ from craftsman-like production;
2) the use of new raw materials; and
3) the use of new sources of energy and/or new tools.

A combination of all three elements can be found in Japan for the first time with the various reverberatory furnaces, blast furnaces, shipyards and spinning mills erected between 1850 and 1868. Even though the number of these industrial sites was limited, we must regard these factory-like establishments as early industrial outposts. They were isolated and in a traditional environment, but they have much more significance for future development than is usually admitted. This period therefore marks the beginning of the industrial revolution in Japan, which came to an end around 1920 with the industrial production system firmly established.

It is usual to view the years between 1850 and 1868, the period of Japan's industrial apprenticeship, in one of two ways:

1) we can regard the capabilities of Japanese craftsmen (and other workers) as being fairly high, or
2) we can take the view that traditional techniques were by no means strong enough to develop an industry (Odaka, 1984, p. 10).

There is also a third possible interpretation for this period. I shall develop this alternative view below.

Among the early industrial establishments, the reverberatory furnaces represent the first western-style industry in Japan that had all three constituents for the qualitative change mentioned earlier. The construction of the furnaces became necessary for Japan because she wanted large iron cannons for her coastal defence which the traditional craftsmen could not produce.

Some authors (Koyama, 1943, 1972; Yamamura, 1977) consider the efforts made during this period by several Daimyo and the Bakufu government to establish Western-style foundries around the reverberatory furnaces to be relatively insignificant and of little relevance to later development. But recent findings by Ōhashi (1975) and Pauer (1983) reveal that many features developed and problems solved at the furnace sites benefitted the following period. The organization of production at these foundries differed completely from conventional craftsmen-like business. All the equipment was different, and some raw materials—for instance fire clay, pig-iron and coal—were used for the first time in such quantities and qualities.

When reverberatory furnace construction started in various domains after 1850, the skills and knowledge of the domestic crafts were indispensable. Representatives of miscellaneous crafts—
stone-cutters, brick layers, carpenters, wheel-wrights, blacksmiths, swordsmiths and foundry masters—were involved. They were to provide a sufficient base of practical skills and experience for the theoretical knowledge of the samurai superiors, advisers and administrators at the construction sites. The craftsmen are said to have been of great help at the beginning of the furnaces' operations. But a closer look into the details of production as described in contemporary sources reveals that this was not the case. It took lengthy efforts to bring several furnaces into operation—suggesting that there must have been problems the respected and experienced craftsmen's capabilities could not solve.

The problem was that the two groups' knowledge was based on different foundations. The indigenous craft know-how was purely empirical, handed down for generations within a group of workers. On the other hand, the expertise of the samurai, mostly well trained ‘Scholars of Western Learning’ (yōgakusha), was based mainly on learning and logic gathered from imported Dutch books. They had thereby absorbed parts of western-style natural sciences, logic and mathematics. Disputes between the two groups were common; when these were solved by experiments, the results were mostly in favour of the yōgakusha. Hardly ever did the solution to a problem come from the domestic craft. In almost all cases the samurai had to study western books or to contact the Dutch in Nagasaki directly in order to answer their questions.

Indigenous technology was not of much help for building and operating the reverberatory furnace. The same was true for the reaction of iron, the handling of raw materials, the manufacture of refractory bricks, and the use of sand for the sand moulds. Even if it would be inaccurate to say that there was no support by indigenous technology and traditional experience, we must regard their contribution as rather limited. The gap between foreign and indigenous technology had to be filled with the help of scholars of western learning. The domestic craftsmen must have had a profound lack of a systematic knowledge of natural sciences. They were advised by the samurai, who had delved into the problems along the guidelines of western science. It was this combination of traditional skills derived from an earlier trial-and-error process and the samurai's study of western books which finally led to success.

We have to acknowledge that at the end of the Tokugawa period, during the stage of transition which I have called “Japan's industrial apprenticeship,” the limits of the traditional crafts had already become apparent. People came to realize that the combination of traditional skills and the samurai’s theoretical knowledge, which helped to get through the first impasses faced in the furnaces, would in the long run not be sufficient to spur the development of certain other industries. The next section will show that the gap between traditional craft and Western-style new industries widened during the following period.

3. The Role of the Craftsmen and “Modern Industry”

Among the various industries in the Meiji-period (1868–1912) not all can be called ‘modern’; even in the late Meiji period whole industrial branches and their production processes did not differ distinctly from the processes already known in the late Tokugawa period. The term ‘modern industry’ is therefore limited to those branches in which Western-style products were manufactured in a Western-style production process; included here are for instance, heavy industry, shipbuilding, the machine-tool industry, and the whole range of metal processing
industries. Most of these can be related to already established complementary branches of which shipbuilding is but one example. The ships produced, however, show striking dissimilarities to Western ones. The same applies for the metal-processing industry, clock manufacturing, and others. The point at issue now is whether in the new Meiji industries the domestic craftsmen were employed in their respective special fields? Did a traditional founder with his mastery of indigenous technology find a job in a Western-style foundry, and a Tokugawa period clock maker in Meiji period clock manufacturing? Is there any evidence that in Japan the traditional artisans' expertise contributed to the introduction of modern industries in certain branches?

For the majority of the industries founded in the Meiji period (the so called ishoku sangyō = 'transplanted industry'), it is to be noted that indigenous technology could not cope with the production process applied in these plants, because the goods were totally unfamiliar. Therefore, a rough distinction can be made:

1) traditional industry, which according to some scholars, is said to have remained unchanged and where traditional technology is turned over (I would like to question this later);

2) 'modern' industry with new techniques and new products, all imported from Western countries; and

3) some branches of industry which could be classified as "in-between," where there might have been a connection between the related branch in the Tokugawa period and further development in the Meiji period. (Concerning this distinction see also Matsuda, 1983.) In order to substantiate this classification, we will use detailed examples, especially for the third category where a distinct function of the craftsmen seems likely.

3.1. Shipbuilding: From Wood to Iron

It was not only because of a different level in technology, or a gap between Japanese and Western standards, that the assimilation of Western technology was a delicate task for the shipbuilding industry. The construction of traditional Japanese ships was by no means simple, and those engaged in this sector—usually carpenters and blacksmiths—needed a certain degree of know-how and skills. Moreover, the construction itself differed greatly from that of Western-style ships. For building the first Western-style ships, there was no choice but to rely on indigenous technology. A first attempt was made in the late 1840s in the Satsuma domain, where a Dutch book on shipbuilding was imported and translated. The technique of Western shipbuilding was then taught to the local carpenters (Kagoshima-ken, 1965, pp. 934–935; Kōdōkan, 1911, p. 147). Another attempt was made by the authorities of Mito domain, who gathered carpenters, blacksmiths and some samurai at Ishikawajima near Edo in 1854. Having studied Western shipbuilding methods from Dutch books, this party constructed a ship called Asahi-maru in 1856. Its outward shape resembled a Western ship, but inside was still totally Japanese, which caused the whole project to flop (Kōdōkan, 1911, p. 931). A symbiosis of Western-style with indigenous Japanese technology could thus not be achieved, despite the fact that craftsmen and samurai had acquired know-how about Western shipbuilding techniques by asking foreign (mostly Dutch) technicians at Nagasaki, and sailors of the wrecked Russian ship Diana in 1855 built a Western-style ship in front of Japanese craftsmen in Heda at Izu peninsula (Ishikawajima-Harima, 1971, p. 2).
Up to then indigenous technology had been sufficient for copying Western models and, at the same time, flexible enough allow improvements in the direction of the much more complicated Western type of shipbuilding. Their understanding of how to make wood available in the various shapes required, as well as the fact that they knew which kind of wood suited best for which part of the ship, helped the Japanese craftsmen to absorb the Western learning on the construction of wooden ships. But the following steps were much harder: gaining a scientific comprehension of shipbuilding and thus being able to repair and build iron ships in the near future.

When the Nagasaki iron work (later shipyard) was established in the mid-1850s, it became necessary to employ several craftsmen in addition to the samurai who had been given preliminary training by Dutch naval engineers. Therefore, carpenters, shipbuilders, blacksmiths, casters and others were recruited from the surroundings of Nagasaki. Contemporary sources, however, have it that these craftsmen had to be instructed in every simple movement of their hands from the minute they entered the yard. To make them familiar with the whole range of Western machines and equipment, a full-scale on-the-job training programme became indispensable. The trained craftsmen were later sent to other shipyards in order to direct other workers likewise (see the detailed study in Nakanishi, 1982, esp. chapt. 3, part IA). Thus, in the newly founded shipyards one could rely on the craftsmen from Nagasaki (and also Yokosuka) to train workers who were not necessarily from related domestic crafts (see the case in Kanazawa in the year Meiji 3/1871 described by Tsukahara, 1978, p. 179).

A similar approach can be observed with the establishment of the Yokosuka shipyard in 1864. Here, too, the Bakufu-government adhered to the general view that artisans from the respective domestic craft would be the ones most capable of coping with Western-style shipbuilding technique. For this reason, domestic carpenters were employed at the yards and blacksmiths at the foundries and iron works (Sumiya, 1977, p. 13). But even they had to be trained in special schools to become real “Western-style craftsmen.”

In the early years of Meiji period, assignments were extended to people with the status of “farmers.” They, too, were trained and later gained good promotion. As with Nagasaki, workers from Yokosuka were also later employed at other yards thereby spreading their knowledge. For instance, Hirano Tomiji from the Ishikawajima-Hirano yard employed workers who had received training at the Yokosuka yard in Meiji 4/1872, while he himself had been trained at Nagasaki (see Ishikawajima-Harima, 1971, p. 8).

Accordingly, being a domestic carpenter or blacksmith was not a necessary prerequisite for becoming a carpenter or blacksmith at one of the modern shipyards. There are examples of casters from the traditional casting center of Kawaguchi being employed at the Yokosuka yard’s foundry, but as a rule they remained in subordinate positions for their whole lives (Sumiya, 1977, p. 83). Only if they obtained additional professional training in Western-style casting, could they advance.

Thus it becomes evident that the reliance on domestic craftsmen and indigenous technology did not last for more than an extremely short period after Western-style shipbuilding was begun in the mid-1850s. Due to the difference in the construction of Western-style ships, be it wooden or iron, the employment of traditional craftsmen soon became obsolete.
3.2. Textile Industry

Textile production (cotton, fabrics, silk, etc.) were important export goods during the whole of the Meiji period and traditional textile industry played a vital role in the economy. However, the role and influence of the traditional textile industry in technical development within the textile industry was rather insignificant.

Nevertheless, textile industry underwent certain changes in technology during this period. For instance, several improvements in silk reeling techniques can be observed during the early Meiji period, some of them based on techniques already known in Japan like the treadle, but most other improvements were based on inventions from Europe, and if not appropriate to Japanese circumstances at least served as models for the improvement of Japanese techniques (see Okumura, 1973, pp. 108-109). Later improvements made by the Japanese technicians were even noted by contemporary European writers as being more advanced than European techniques of the time (see Bolle, 1898, pp. 75-77).

Even in silk reeling, then, traditional tools changed already in the early Meiji years under the influence of foreign ideas and foreign machiners and so can no longer be described as totally indigenous. Over and above such improvements, imported silk reeling equipment spread all over the country and the output of Western-style silk reeling products exceeded silk-reeling based on traditional techniques in the early 1890s.

The development of cotton spinning and weaving in the Meiji period depended to a great extent on imported machinery. This meant that the connection between indigenous and modern techniques in these branches was virtually nil. However, reference must be made to the invention of the garabō spinning tool which came entirely from Japanese indigenous technology. This spinning tool which utilizes cotton waste, produced very coarse yarns that was incompatible with the new Western-style weaving machines. As production with this tool was very high, it was commonly used in industries producing for the domestic market, but even there its influence diminished in the early 20th century (Yamazaki, 1961, p. 41).

Cotton fabrics for export could not be manufactured on the traditional looms, because they were not suited for the production of broad width fabrics for the international market. Western-style machines had to be used but these machines were usually not adaptable for the cottage industry with its “putting out” system. Therefore, no gradual transition from traditional to modern technology occurred, but indigenous textile industry and Western-style textile industry based on modern imported machines existed side by side for some time, after which the latter replaced the former.

Having looked at the equipment of textile industry we have not found any direct connection between indigenous and imported technology. But what about the people employed in the modern factories? Did Meiji period modern textile industry rely on people who had been engaged in such industries earlier? When the first Western-style spinning mill was established in Kagoshima shortly before the Meiji restoration, it was not those already familiar with spinning who were engaged, but people who had not undergone any professional training in this field (Sumiya, 1977, p. 50). At the various mills founded subsequently, people who had been seamen or ordinary labourers were also enlisted, as well as workers who could not even count (Sumiya, 1977, p. 63). From Kashima spinning mill in Tokyo, also founded in the late Bakumatsu period,
it is reported that the employees often were female and male house-servants from Edo/Tokyo, who disliked their jobs and were in search of a new kind of work (Sumiya, 1977, p. 53). Hence, being familiar with the traditional spinning business was not a prerequisite for being hired at one of the modern spinning mills, and in particular the cotton mills.

The same applies for the silk-reeling business, where mainly young females from the samurai class were employed. Therefore, in most parts of the spinning industry there seems to be hardly any connection between traditional craft and modern industry.

3.3 Clockmaking

As early as in the Tokugawa period Japanese clockmaking was quite a flourishing craft. But with the switch from the traditional lunar calendar to the Western solar calendar in Meiji 5.12.3. (1872), the traditional clockmakers lost their jobs.

Usually we would assume that because of their basic knowledge of clock mechanics and the functions of a clock, it would have been quite easy for them to change profession. There was one crucial point, however: the technical gap was too vast to be crossed easily. As a rule Japanese clockmaking relied entirely on handwork, whereas Western clockmakers already worked with machines. Therefore not only the technique itself but also the whole manufacturing process was entirely different.

While imports of Western-style machinery had already started in the late Bakumatsu period, they were generally limited to the newly established heavy industries. Precision instruments and machinery for other materials and smaller parts (as for working the brass required for clock-making) were first introduced in Japan in the newly established Osaka mint, the telegraphic school and the army arsenal in Tokyo, where foreign engineers gave instructions for the use of the new equipment (Uchida, 1985, pp. 179-180).

As their traditional skills were of not much use, some of the domestic clockmasters turned to the clock importing and selling business and, at the same time also engaged in repair business (Kikuura, 1980, p. 224; Uchida, 1985, pp. 175-176). Spare parts had to be imported for mending Western clocks. Through the repair business and their background knowledge of indigenous technology, these clockmakers were able to assimilate a great deal of Western clockmaking technology. This must be regarded as a necessary prerequisite for at least some of those people who set up clockmaking enterprises after Meiji 20/1887. However, most of those who founded their own enterprises in the middle of the 1880s, had been mainly educated either in a European country (in Switzerland or the Netherlands) or had been trained at the Osaka mint or the army arsenal and the telegraphic school in Tokyo.

In 1867, a Japanese "engineer," Yasuzaburō Ono, had been sent to the Netherlands to study Western clockmaking. He then became the central figure of the Osaka mint and taught dozens of workers in Western clockmaking techniques until his death in 1886. Those who were schooled under his guidance later became technicians or foremen in clockmaking factories and workshops (Takechi, 1980a, p. 2; Uchida, 1985, p. 181). The machines used in the mint could also be employed for making parts of clocks. These machines included the minting press and precision bench lathes. The Osaka mint made its first clock in Meiji 9/1876.

After samples were imported in Meiji 7/1874 the manufacturing of telegraphs started in the
Tokyo telegraphic school. One of the responsible “engineers” was the distinguished mechanic Hisashige Tanaka (concerning his role, see Uchida, 1985, pp. 182–183), who had a high reputation for making not only mechanic dolls, but also clocks and even telegraphic machines. He had also studied Western techniques overseas, in Shanghai, (which is why he cannot simply be called a domestic craftsman). Apprentices in the telegraphic school learned on the job how to make cogwheels for instance with the imported machines, by copying Western production methods.

The number of people instructed in the mint, the telegraphic school, the arsenals and other places, quickly increased. The fundamentals of setting up a clockmaking industry must on the one hand be ascribed to those who were familiar with precision techniques and the use of bench lathes and other machinery necessary for clockmaking, and on the other hand to a broad spectrum of craftsmen capable of making clock cases, minute hands and other minor parts with traditional techniques. This latter group worked as subcontractors and comprised woodworkers, lacquers, jewellers, tanners, enamelling and plating craftsmen and also metal workers. In early Meiji Tokyo they numbered about 5,000 (Uchida, 1985, p. 186). Around the mid-1880s the onset of a clockmaking business was facilitated by another fact: the precision machines required for clock production became available through foreign importers and even in the second-hand machine markets in Japan (Uchida, 1985, p. 186).

A closer look at the career of some clockmaking entrepreneurs in Meiji Japan reveals that even if in some cases their ancestors had been engaged in traditional clockmaking, they themselves usually came from the clock selling and repair business. One example of this kind of entrepreneur is Ichibee Hayashi from Nagoya. In Meiji 13/1880 he employed three precision-metal workers and ventured into fabricating parts of Western clocks, but in spite of vigorous efforts he failed because he could not contrive in making of the cogwheels. He then studied the machines at the Osaka mint and also at the telegraphic school in Tokyo, and when returned to Nagoya, he tried to make and eventually succeeded to make his own press. He also soon constructed the other essential implements on his own. The employed metal workers (one of them is said to have made clocks beforehand, but this is uncertain due to a lack of sources; the other was originally a lathe-turner) became something like instructors and foremen in the manufacturing business Hayashi established five years later, and schooled other hired metal workers (Uchida, 1985, pp. 218–222; Takechi, 1980a, p. 4). Another example is Kintaro Hattori, born in 1860 as a son of a second-hand goods shopkeeper in Edo, who became an apprentice at a clock shop in 1874. In 1877 he established his own repair business, and by helping out at other shops he became a well-trained mechanic. Together with another clock repairer he founded a factory in 1892. They recruited workers from the clock manufacturing center at Nagoya, and by using manpower-driven lathes, they produced their first clock in the same year (Hirano, 1972, pp. 15–16, 22–27 and 42–44).

It can be inferred from these examples (a number of others could be added) that there is a generation gap between the breakdown of domestic clock manufacturing and the rise of Western-style clock production. A direct technological connection between the two “crafts” seems to be rather doubtful. Conventional Japanese-style clockmakers were not employed in the newly established Western-style clock factories. The workers were mostly trained in Western-style factories run by the government. All stemmed from other crafts, and were already familiar with
Western machines. The only tie between the old and the new industries lies in the early Meiji period, when traditional clockmakers were engaged in repairing Western clocks. There is no evidence of any other linear linkage.

3.4. Bicycle Manufacturing

Bicycles were completely new to the Japanese, as in contrast to the products already mentioned, there was no bicycle manufacturing in the Tokugawa period. It is understood that one of the first bicycles in Japan was made by a certain Eisuke Miyata, a well-known gunsmith. It is interesting that it was a gunsmith who entered this business. It might be possible here to discover a connection between traditional craft and modern industry.

The bicycle repair business was already developed in early Meiji. Turners, blacksmiths, gunsmiths, pump-men, clockmakers—the whole broad range of metal-processing craftsmen—were engaged in this business. They used simple tools, bellows, vices and heat to manufacture parts themselves, and even assembled bicycle parts (Takechi, 1980b, p. 10 and 13).

Eisuke Miyata was born into a farmer's family in 1840, worked at a gunsmith's workshop and was later promoted to "gun-master." When he lost his job in the wake of restoration he turned to making Jinriksha in Meiji 9/1876, but later got employed at the army arsenal in Tokyo. In 1881 he established his own gun factory with the initial equipment of two vices, one pair of bellows, an anvil and a treadle lathe he borrowed from another gunsmith (Miyata Seisaku-sho, 1959, pp. 1-4). Even though his company was called a gun factory, by 1884 he was producing a great variety of articles: gunsi telegraphs, pumps, surveying equipment, compasses, ramrods and knives, and other things for the army (Takechi, 1980b, pp. 14-15; Sano, 1985, p. 117; Miyata Seisaku-sho, 1959, pp. 1-4). In 1883 his second son joined the business after being an apprentice at other gunsmiths'. When the first son entered his father's company in 1887, the second son joined the Osaka army arsenal, where he studied new Western-style precision machines. Miyata himself examined the manufacturing processes of telegraphs at the famous Tanaka (Hisashige) factory. After mending a foreign bicycle for the first time in 1887, he soon entered this business. Shortly afterwards he and his son thought of manufacturing bicycles themselves, but since their equipment was not yet sufficient for making all the components, they started with the frames.

For the tubes they applied a traditional method for gun barrels called kuri-nuki (= winding and pulling out) (Miyata, 1902, p. 55). But the tubes were not the only challenge; another lay in the hardening. Here, Miyata could also fall back on the experience he had gathered earlier in the production of ramrods. Due to the insufficiency of his tempering techniques he at first failed, but by a trial-and-error process he improved his methods and finally succeeded. His method of hardening and tempering the tubes for the bicycle frame by steam heat (which had already been applied for tempering gun barrels), led to good results, especially in the hardening of the tubes' surface (Miyata Seisaku-sho, 1959, pp. 1-4, 14).

What can be seen from this example is that even if to some extent the gunsmith's work was a traditional craft, it had already undergone great alterations in the early Meiji period. Moreover, although the method for producing the barrels remained unchanged (because no other machine could be afforded), the hardening and tempering technique with steam can in no way be called indigenous method. Thus the basis of the new business was not solely the indigenous technique.
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but foreign methods as well. As there were parts which were different from those manufactured traditionally, new techniques had to be acquired.

The various memoirs of bicycle entrepreneurs in the Meiji period show that their lives followed nearly the same pattern:

Shōzaburō Shimano was born in a farming village near Sakai in 1868; he became employed first as helpmate fitting blades, but at the age of 16 switched to repairing bicycles. Later he worked at the army arsenal and various other workshops as a wandering craftsman, thereby accumulating multiple skills (Sakamoto, 1980, p. 40) before establishing his own company.

Yoshikichi Maeda, born 1865, underwent professional training at a gunsmith’s and subsequently found employment at a gun factory in Tokyo. He opened a workshop for bicycle parts in 1898.

Kitarō Ōizumi from Tokushima, at first schooled by his brother who was employed at a gunsmith’s in Sakai, later became employed by Yoshikichi Maeda and finally established his own workshop.

Yūnosuke Watanabe, born 1867, became a metal (iron) worker and went to Sakai where he fabricated metal tools. Relying on his experience he started manufacturing bicycle parts in 1901.

Hōemon Hamada, born 1877 in Tokushima, Awa, was trained as a gunsmith. As an employee at Watanabe’s workshop he learnt how to make a bicycle with the various machines and afterwards turned to bicycle-fork manufacturing. (All examples from Sakai-Rin-gyō-kai, 1939, pp. 33-35).

But it was not only the gunsmith that gave the initial impetus. Eikichi Matsushita from Noto worked first at the Ishikawajima shipyard and then at the Shibaura factory. Owing to his sophistication he managed to enter bicycle-making in 1898 (Takechi, 1980b, p. 10).

Some of the workers engaged in bicycle manufacture had been trained beforehand in other modern factories, such as the telegraph manufacturing plant of Hisashige Tanaka (Takechi, 1980b, p. 21). Others came from the army arsenals in Osaka or Tokyo, where bicycles were already manufactured for military use in huge quantities from Meiji 30/1897 onwards.

These examples show that the roots of quite a number of entrepreneurs in the field of bicycle manufacturing can be traced back to the gunsmith’s craft, and several of the employees had the same background. It is now in question, however, whether these people still were the same craftsmen as had been their forefathers in the early Meiji or even in the late Tokugawa period.

We have found out that to a certain degree indigenous technique was relied upon. This—no doubt—made it easier for the gunsmiths to get involved in bicycle manufacture. Furthermore, at this time the gunsmiths already had a complete command of a broad spectrum of metal-working techniques including hardening, tempering, turning, welding, soldering and others, all of them necessary for the production of bicycles. But the techniques applied in the mid-Meiji period cannot longer be rightly called domestic, indigenous or traditional. They had already changed under the influence of Western knowledge and techniques, which most of the so-called gunsmiths had acquired at the arsenals and other state-run factories. Even a traditional town as Sakai, where many old metal crafts were concentrated, fell under the Western influence during the Meiji period. Stemming from the group of traditional blacksmiths, gunsmiths and other craftsmen, a kind of “machine-using smith” was born. The terms “machine-smith” or “Western-
smith," which came into frequent use at the end of Meiji, indicate, that these crafts already employed lathes, power-driven grindstones and other machines (Sakamoto, 1980, p. 138). It would be wrong, however, to call these craftsmen domestic or traditional, as their sophistication accumulated in the course of working at newly equipped factories makes them quite different from workers in craft rooting in genuine Japanese tradition and indigenous technology.

3.5. Coal Mining

Parallel to the industrialization process, coal mining became an important sector of the modern Japanese economy. Although its beginnings date back to the 18th century, and it could therefore be called a traditional craft, modernization was not achieved solely by employing domestic miners. The modernization of the coal-mining industry was actually achieved by a cooperation of domestic mechanics supported by indigenous miners and foreign engineers and/or techniques. Extraneous guidance thus helped to utilize the traditional know-how of the indigenous miners and “engineers” in the modernization process, in the course of which the modern Western mining methods were absorbed. The process could only be successful, however, when foreign technology was not imposed at a single blow, but was assimilated step by step, making it possible for the traditional miners and engineers to accommodate smoothly to technical operation changes and gradually to advance. This was the case only for the modernization in the most famous early mines at Takashima and Miike (Murakushi, 1979). The unsuccessful attempts at other sites started in the late Tokugawa period bring to the fore the advantages enjoyed by these two mines. The effort to open up mines in Hokkaidō failed because there had been no traditional mining and accordingly no experienced miners (“experienced” meaning versed in the traditional mining method). Hence a traditional, let alone a “modern” style, mine could not be installed due to the lack of indigenous expertise in mining. Therefore even the hiring of a foreign engineer did not lead to any substantial improvements.

Attempts to enhance coal mining in Northern Kyūshū in the early Meiji period ended up in nothing. Even though foreign machinery, especially pumps and steam machines, were bought, and Japanese mechanics (trained at the Nagasaki shipyard and therefore familiar with Western machines) were employed, all endeavours fell short. The Japanese lacked the guidance from foreign mining engineers, as their genuine traditional learning was too limited to be good for the operation of the newly purchased Western machines (Murakushi, 1979, pp. 467-468). The later process of modernization of this area clearly indicated that once more the lead of Western technology was necessary combined with indigenous cognizance.

The first fruitful attempts in Northern Kyūshū must be attributed to two people originating from the samurai class. One of them started to pick up Western-style mechanical technologies at the Nagasaki shipyard (foundry) as early as in 1856; the other studied mechanics by reading Western books and hiring mechanics from the advanced mines. Both were not miners or mining engineers in the narrow sense, but started with the mechanization of mines in total dependence on foremen, i.e., leaders of indigenous miners, who became foremen because of their exceptional skill, know-how and other qualities. Western-style techniques in the mines were still confined to drainage and coal transport, with traditional methods of extraction prevailing.

Only when the miners trained in Western-style mines, i.e., Takashima and Miike, changed their
working places, thereby spreading their knowledge, did innovation expand. Once again, the Western techniques taught to certain miners were then passed on to others (Murakushi, 1979, pp. 470-471). Contemporary sources (cited in Murakushi, 1979, pp. 478-480) state that the foremen usually had a good command of conventional coal-mining technology, based upon long experience as pitmen in coal mines. Moving from one mine to the other, they met with several methods of extraction, and these acquisitions enabled them later to instruct other miners. Some of these foremen had also worked at the Takashima or Miike mines, or other already modernized mines where Western-style machines and methods were in operation (Murakushi, 1979, p. 481). The thus accumulated and partly Western-style technology made for the diffusion of Western technology into other mines.

3.6. Glass manufacturing

The early glass industry in the Meiji period also shows that it was next to impossible for the traditional craftsmen to achieve satisfactory results despite using imported Western machinery. An early private glass factory was established in Shinagawa, Tokyo, in 1873 with equipment imported from England, and a foreign adviser was employed. The labourers were all qualified craftsmen stemming from traditional glass manufacturing workshops in Osaka and Tokyo, where the glass industry had a long tradition. But they could not achieve good results, especially not in glass plates. A complete failure, the factory was sold to the government in 1876, and was then turned into a state-run laboratory-like institution. Success was achieved thanks to the employment of a Japanese engineer, who had studied traditional glass making in Saga in the late Bakumatsu period and then had improved his knowledge in Nagasaki and later in Europe, where he studied Western glassmaking methods in 1873. His knowledge of the technique of glass production radiated from the Shinagawa institution to all other glassmaking plants throughout Japan (Kikuura, 1979, pp. 6-7).

This example further backs the observation that even highly qualified traditional craftsmen were not able to achieve good results without a profound basis of Western learning, even if Western equipment and machines were available.

3.7. Button Making

There are only a few instances where the traditional skills were sufficient also for new Western-style manufacturing industries. One of these is the shell-button industry which was established in Japan shortly after the Meiji Restoration. Cutting the shells with knives and shaping them by hand were basic skills also needed to produce other articles in earlier times. Therefore, craftsmen immediately—or at least fairly rapidly—understood how to make Western buttons. Improvements made for shaping several shells at a time, or for achieving a certain thickness, were all derived from traditional skills (for more details, see Takeuchi, 1979a and 1979b). The transition from handwork to the use of simple machines was also based on traditional knowledge of, for instance, the use of springs, a drill shaped like a breast drill (with a U-shaped handle) and others. But the most important impact on the improvement of production methods once more came not from the traditional craftsmen but from the contact between a buttonmaker and a Western-style blacksmith or metal worker. Not only did he suggest a different arrangement of the cutting
tools, but also gave advice in how to use metal drill bits. The new arrangement was further elaborated in the following years by using water power and water wheels (Takeuchi, 1979a, pp. 424-425 and 1979b, pp. 6-8).

Attention should be given to the fact that again it was a Western-schooled metal worker who gave advice and, as we have seen above, in this branch Western methods were already predominant and led to improvements in other branches as well. In the late Meiji period button making manufacturing absorbed a huge number of workers who, by their job turnover spread the new techniques rather quickly.

3.8. The Casting Craft

In the Meiji period there was a great demand for cast iron tubes in all sizes by factories, shipyards, arsenals, and especially the mines, which required them for drainage. A large proportion of these tubes were imported, but from Meiji 10/1877 onwards there are reports of a traditional workshop called Taniguchi Seihachi Kōjō in Saga, a factory with some 60 workers, where drainage pipes were cast (Ichikawa, 1984, p. 20). But probing a little deeper, we soon find out that here it was by no means a “traditional craft” which took a leading role in the Meiji economy. True, this workshop can be traced back to the traditional foundry masters’ family of Taniguchi in Saga, but this family had played an important part in the Western-style reverberatory furnace business in the Bakumatsu period and could obviously expand the experience gathered there for the further development of their workshop, thereby assuming a leading position in the casting of iron tubes. The Taniguchi factory is referred to as a remarkable example for the development of a traditional foundry influenced by Western techniques which made its way into the modern economy, but this workshop can be called a “traditional” one only in a limited way.

In 1901 the so-called “traditional” foundries supplied 50% of the cast tubes in Japan. Other factories similar to Taniguchi’s provided their share. It is reported that in 1889 Masuda factory in Kawaguchi delivered cast iron tubes for the water supply system in Hakodate (Ichikawa, 1984, p. 15). But those who take this for at least one example of a real traditional casting craft taking its chance will soon be disappointed, because tube production there had been improved by technical information from the Yokosuka shipyard; this means that this “traditional” craft, too, was no longer traditional. The same applies to other factories mentioned in the sources.

The change in the casting craft during the Meiji period were so fundamental that close to no establishment can legitimately be called “traditional” anymore. From the Bakumatsu period to Meiji 10/1877 the first substantial alteration affected the heating material, when charcoal was displaced by coke. Setting in simultaneously and originating from the reverberatory furnace sites, the progress of changing from sand moulds to steel moulds can be observed until the mid-1880s. Another break is related to the raw materials: cast iron gained from traditional sand-iron production was replaced by blast-furnace pig-iron mainly imported for the foundries after 1880, and after 1890 coming from the Kamaishi iron works. Finally, the traditional hand-bellows were replaced by power-driven bellows (steam, electricity) after the mid-1880s.

This, in the late 19th century none of the so-called “traditional” foundries was really traditional in the narrow sense that tools, raw materials, processing methods or technical standards were the same as in the late Tokugawa period. In late 19th century the casting craft had substantially
altered, and if it must still be called a craft, it was a thoroughly modernized one.

4. Conclusion

At the end of section 2 we arrived at the conclusion that the traditional craft did not make a substantial contribution to the early beginnings of the Japanese industrialization. In section 3, this conclusion was further substantiated by numerous examples given for the development in the Meiji period.

Without doubt there were branches in which traditional knowledge and skills were applied and expanded for the production of Western-style articles without much difficulty. However, as soon as the fabrication of Western goods required elaborate skills and techniques which did not emanate from the traditional production process, the domestic crafts reached their limits. “Accuracy” for instance, was one of the crucial obstacles which the indigenous crafts could not surmount without the help of Western science and technique. Our various examples lead to the conclusion that the role of the traditional crafts in Japan’s industrialization is usually overestimated.

The great number of craftsmen employed in Western industries in the Meiji period is no proof against this statement, since the examples cited above make it clear that these craftsmen were by no means any longer “traditional.”

Concerning the relationship between craftsmen and industrialization, the following points should be considered:

1) The traditional craftsmen did not further the industrialization process itself, but their crafts and skills provided the fertile ground in which the seeds of Western knowledge could germinate and flourish.

The traditional Japanese craftsmen cultivated and accumulated technologies and methods in their respective crafts by long trial-and-error processes, through which they consequently reached a comparatively high standard. These skills formed the base for some representatives of the traditional crafts to enter Western business in the Meiji period. This is because it makes a great difference in one knows about the function of (for instance) a lathe, or at least the functional principle of a Japanese lathe, even if it is very primitive compared to Western lathes. A basic understanding of the traditional Japanese lathe, the function of the lathe spindle, the use of a tool post, the various lathe tools and the connection between a remote power source and the motion of the spindle, substantially facilitates the introduction and application of modern tools. The same applies for the casting craft. If someone has a command of heating and smelting metals and making moulds, and perceives the problems of cooling down cast articles, it is at least somewhat easier to introduce better moulds, better fuels, etc., than if such fundamental knowledge is completely lacking. This is also true for the ship carpenters: as we have seen, they possessed a basic comprehension of woodworking, and it needed just a little training to enable them to build Western-style ships.

In most cases, Western knowledge available from numerous sources in Meiji period provided the help for surmounting the obstacles, but subsequently this led to the alteration of the craft.

2) Traditional craftsmen in Japan were highly skilled even by Western standards, but this standard was not high enough for immediate application in Western-style enterprises. Neverthe-
less it was exactly this standard which prepared craftsmen to adapt themselves, their techniques and their tools quickly to the new conditions of the early Meiji period. This paper gives examples of the casting craft, but the same can also be detected in the urban turner’s craft, where Western-style lathes with a treadle for moving the spindle were used in the first decade of the Meiji period. At nearly the same time a treadle-driven Japanese lathe can be found with the kijiya’s, the wandering lathe-turners. It is rather doubtful, however, that this treadle lathe is an indigenous invention as it is sometimes called (e.g. Meiji-zen Nihon Kagaku-shi Kankô-kai, 1973, p. 268), because the wandering lathe-turners themselves formed a quite well-developed organization with good connections to the centres of modernization such as Osaka, where the Western treadle lathes came ashore. Therefore it must have been quite easy for the experienced turners to copy the Western treadle and replace the indigenous tool.

This leads us to the next point:

3) Copying tools is an important way of technology transfer and development, but it cannot occur in a vacuum; a certain standard of skills is necessary for the imitation of machines and the adoption of hitherto unknown techniques. This is exactly where the traditional craftsmen comes in as an indispensable “go-between” for copying Western machines. The process of imitation, however, was accompanied by the important aspect of substituting the materials; as a rule, iron or metal parts were replaced by parts of wood. Accordingly modifications of the machines often became necessary, because the metal parts of a machine cannot be simply exchanged by parts made of wood, but the construction of the whole machine, or the arrangements of single parts must be adapted to the specific material. This often led to a simultaneous simplification of the machine (see Takeuchi, 1979a, p. 426 and 1979b, p. 9 for examples in the shell-button industry). The thus created simplified Western-style machines could be handled by workers with limited performances, who consequently became so-called “craftsmen.”

Another good example for such a copying, transformation and implementation process is reported from the silk reeling factory in Tomioka, a state-run pilot plant opened in 1872, where the workers were schooled at Western tools and machines. Back home, they instructed their local craftsmen how to construct such equipment, but as copper, iron and brass were expensive and difficult to process, these materials were mostly replaced by wood (Okumura, 1973, pp. 108–109). The machines built after this pattern were indeed inferior to the Western ones, but nevertheless the products sold with a profit on the market.

The textile industry provides another well-known example of the substitution process. Sakichi Toyoda, who was trained as a carpenter, succeeded in constructing the first manual looms made of wood, not of metal, and thereby founded the domestic textile machine industry (Kajinishi, 1962, pp. 29–34).

Thanks to the material substitution, the new machines not only became easier to handle, but also much cheaper than their Western models. Through the substitution process the traditional crafts thus to a certain extent contributed to the diffusion of Western machines as well as Western production processes.

4) The introduction of new techniques and the use of new machines broadened the general knowledge of the craftsmen, and became part of the general knowledge of all people. In this way, the traditional craftsmen found their specific role especially in small-scale industries, and were
thus necessary for the following industrialization period. But this process is far from what could be referred to as the "spontaneous growth" of the traditional crafts setting in in the late Tokugawa period, as Toshio Furushima said. Craftsmen did not stand back, and they did not linger at the level of, say 1850, but their means of production changed quickly. I doubt that it is correct to lump together the craftsmen of the late Tokugawa period and the Meiji period even if they are in the same branch. The techniques, the tools, the articles and their quality underwent such extreme changes, that besides their titles, there is little similarity between the individual crafts of the two periods. There is a great difference between a craftsmen of the mid- and late-Meiji period and one of the late Tokugawa period. This change is the reason that the so-called "craftsmen" played an important role in some manufacturing branches, for instance in clockmaking or bicycle manufacture. Even when the craft was handed down from father to son, the latter usually received additional training in Western-style factories or arsenals, thereby obtaining a general understanding of Western techniques, tools and know-how, which he could later apply to his own workshop. That means:

5) What helped the representatives of specific crafts to enter new businesses was not only the import of modern tools and machines, but also the education that went along with them and, in particular, vocational training. We have seen a lot of examples of traditional craftsmen being employed at the shipyards, but these are not as numerous as the examples of craftsmen who were employed at the various technical schools (which were in fact sometimes factories) and the Army and Navy arsenals and other military facilities. These workshops, being technologically superior to the other domestic workshops in Japan, actively aided the private sector, first in supplying equipment and machines, often second-hand, and second (but just as importantly) in training workers within the arsenals. When these workers subsequently moved on to private firms, they brought with them a superior knowledge of techniques, tools and skills.

The important point here lies in the fact that, contrary to the Tokugawa period, we find an unexpectedly high turnover rate among craftsmen. These "craftsmen" can be called something like "wandering craftsmen," and on their way, they worked under different masters in different types of workshops using different (Western-style) machines. Thus, they did not only collect and improve their skills, but also pushed their colleagues to higher levels, and at the same time spread their skills among other workers.

Diffusion of technology from arsenals to private factories and workshops occured especially in the metal-working industries, where machine tools and other Western equipment came to be employed. And even if the technological level in the private factories was not as high as in the arsenals, i.e. using flywheels moved by manpower instead of steam engines, the means of production were quite similar. True, for the production of certain goods such as bicycles, some branches stuck to some traditional skills, but still the arsenals must be called "conveyors," i.e. places where foreign technology is transmitted to domestic crafts and workers, thereby exerting such a great influence that they cannot possibly called traditional craftsmen any longer (I think the term "conveyor" was first used by Yamamura, 1977, p. 132, and gives an excellent definition of the function of the arsenals). We have seen examples of such a conversion in clock- and bicycle-making, but it can be observed in the casting craft and other fields as well.

6) In consequence, we have to take a look at the industrial facilities, too. Dividing the fac-
tories and workshops of the early Meiji period into “traditional” and “modern,” thus implying the existence of totally unchanged old-fashioned workshops on the one hand, and completely Westernized factories on the other, is evidently not correct (concerning this point, see also Matsuda, 1983). There existed a huge number of establishments which rather must be called “in-between” or better “hybrid,” where traditional craftsmen were employed and trained to operate Western-style equipment, tools and machines. In the early Meiji period a great number of such new-type industries emerged, which made not only traditional Japanese goods, but also Western-style products. This gave an additional impetus to the so-called “spontaneous growth” of the domestic crafts, which were, as already shown, by no means “traditional” in the strict sense of the term.

By now we can see that our argument that the traditional crafts did not support the industrialization of Japan is reversed. The process is quite different:

Traditional crafts played only a limited role in the development of the so-called modern industry, the modern factories. Conversely, modern factories influenced traditional crafts to such a great extent that, in consequence, mid- and late-Meiji period crafts were completely different from what they had been in the late Tokugawa period. Accumulated traditional skill entered into a symbiosis with technology based on scientific learning and thereby backed up Japanese industrialization.

(University of Marburg)

REFERENCES

Translation of the titles is given by the Editor of the Journal.


Kagoshima-ken, ed. (1965) Kagoshimakenshi [History of Kagoshima Prefecture], Kagoshima.


E. Pauer: Traditional Technology and Its Impact on Japan’s Industry during the Early Period


Sakai Rin-gyō Kyōkai, ed. (1939) Sakai no Jitensha [Bicycle Made in Sakai], Sakai.


