Chap. 10 : technology for the textile industry (part ii. case-studies)

10

Technology for the Textile Industry

The Textile Industry's Place in the History of Japanese Technology

The textile industry had a decisive influence on and was a leader in the economy and technology of modern Japan. Much has been written on this, and I have benefited greatly from the work of previous scholars. Of interest here, however, is the industry's relation to development and technology transfer.

Characteristics of Technology Transfer

In contrast to the shipbuilding, iron manfacturing, and railway industries, which developed in response to the "needs of government," the technology of the textile industry was developed to meet the "needs of the people." Specifically, the industry developed by supplying good-quality cotton cloth at low prices to people who had been "half naked," according to the record of a British traveller in Japan immediately after the opening of the country. This development was accompanied by a revolution in materials, wherein linen was replaced by cotton, a change that was reflected in the dyeing process as well. Besides dark blue and brown, woven fabrics of striped patterns using dyed yarns were produced, and these diversified and enriched the market for cloth.

Clothing was expensive and therefore used and mended carefully. Old bits were stitched together to form new pieces, and quilted waterproof winter coats were made by sewing with thick threads so many times that the original piece could no longer be discerned. Silk clothes were passed down for several generations and could be sold for a good price if the need arose. There was a big demand for used clothing; indeed, each entertainment district in today's Tokyo previously had a market for used clothing, and a used-clothing network covered the country. The markets and routes of those days have

become the distribution bases and routes for today's ready-made apparel (Nakagome 1982). In short, the technological changes that took place upstream were smoothly channelled downstream to create fertile new fields of trade expansion.

Regarding production, only spinning, which demanded a high input of labour and skill, was mechanized and modernized, as power spinning was 20 times more efficient than manual spinning. Weaving, however, was left to traditional technology (Ishii 1986). Modern technology was transferred only in the spinning division partly because Western weaving machines could produce only broadcloth, while the demand in Japan was for narrow cloth. Thus, modern technology did not eliminate all traditional technology; rather, both shared interdependent or mutually supplementary relations, and, for these reasons, the textile industry and its technology became stable and could develop into a national industry.

The links established between domestic and foreign technologies and between old and new technologies are the most important factors for the formation of a national technology network. In the textile industry, the links between the old and the new expanded and deepened the network of factory, urban-centred, mechanized labour on the one hand and domestic, dispersed, manual, traditionally oriented labour on the other. Thus, foreign industry was transformed into native industry.

As mentioned, power spinning was far more efficient than manual spinning, but the switch was not made without a careful consideration of what technology would best suit the existing needs and conditions. The mule spinning machine was the first to be imported, but it was replaced with the ring spinning machine in less than 10 years. The ring machine was imported not because it was the most advanced but because it required fewer skills and could be operated by low-waged women workers. The mule machine required skilled manual labour, traditionally that of only adult males; and it took a long time to form such skills. How significant the skill-saving was could be seen in the fact that productivity in Japan even with the highly efficient ring spinning machine was only one-fourth to one-eighth the productivity of a skilled British worker operating a mule machine. Although it is dangerous to make simple comparisons between workers' skills, we estimate that there were differences in output of 12 to 20 times. This great difference led to widespread adoption of the ring machine.

It must also be pointed out that there was a big demand for the thick, low-count yarns that were suitable for the ring machine. But the ring did not completely displace the mule (this is discussed in more detail later), as the mule machine was suitable for thin, high-count yarns used for high-grade goods. Nevertheless, the ring machine took the lead in the industry and the technology, but, to the extent that it did not represent a displacement of older technology, a connection between old and new technologies was established to create an extensive market and, thus, a new national industry.

The important aspect of this development was that, rather than an unconditional or blind transfer of the most advanced technology, the selection of a

technology was made based on rational judgement in terms of skill-formation costs and marketability.

The Role of Government

The Spinning Industry

The development of the spinning industry owed much to the efforts of private individuals, men like Shibusawa Eiichi (1840–1931), a characteristic peculiar to the spinning industry. Furthermore, although mining technology, for example, was also developed by private companies, the mines formed isolated "enclaves of compound technology," while the spinning industry was urban, with large-scale plants clustered around the Kansai area, especially in Osaka. The silk-reeling part of the textile industry operated on a smaller scale and was scattered over a broad area.

This difference between spinning and silk reeling was determined by the supply of raw materials. Silk reeling existed where the raw materials were produced because of the particular time and seasonal constraints associated with sericulture. The cotton-spinning industry, on the other hand, used imported materials, and so the factories were near ports and the centres of consumption. In both industries, the labour force was made up mainly of women. The two industries also differed in terms of basic operation; that is, the silk-reeling industry did not operate from winter to early spring, and workers were contracted by the year. In the cotton-spinning industry, a 24-hour, 2-shift (daytime and night-time), all-year system was in force, and the contracts were signed usually for three-year periods.

Cotton was grown nearly throughout Japan, and, as a commodity and for domestic consumption, it was the most important crop after food crops. However, because of the diverse cropping conditions of each region, cotton quality was not uniform, nor was cotton suitable as a raw material for machine spinning, a main reason why imported cotton was used. As a result, Japanese farmers lost an important income source, which, in turn, contributed in its way to the conditions whereby the spinning industry employed farmers' daughers for work in the mills. In the southern part of Osaka, which was a major cotton-growing area, farmers attempted to cope with this difficult situation by means of producing shell buttons, hairbrushes, and later, eyeglasses and miniature lamps for Christmas, all of which were mainly for export.[41]

Despite such differences between the spinning and silk-reeling industries, initial technology transfer was made by the government in both cases. The government-operated model spinning and silk-reeling plants were, however, short-lived. Both were poorly managed, and a fiscal crisis of the new government was an impetus for their sale to the private sector.

Where the government succeeded was in the transfer and diffusion of technology in silk reeling. Although Japan was an underdeveloped country in

silk-reeling technology, it accomplished the targeted goal of earning foreign currencies from the export of silk.

In the spinning industry, it was successful in substituting its own products for imports (which had accounted for 30 per cent of Japan's total imports) and later started to produce goods for export.

Nevertheless, this partial success was overshadowed by the government's failure in terms of business management. For example, in the spinning industry, the government set up 10 small plants (each with 2,000 spindles, that is, a set of 4 machines, each with 500 spindles) in various places in Japan. The 10 plants were part of an anticipated 255 plants that, if established throughout Japan, would make possible the complete replacement of imports with domestic products. These first 10 plants did not succeed, however, and among the causes for the failure, the following could be considered as the main contributing factors:

1. 2,000 spindles were too few to cover costs, but the government could not afford to make additional investment to attain economy of scale.
2. Because the power source was the water-wheel, spinning had to compete with rice cultivation for water, and farmers had a vested priority. During the winter, free from this competition, the spinning industry was nevertheless plagued by a shortage of water, which prevented it from operating continuously throughout the year. As an alternative, some plants adopted wood-burning steam-engines, but wood was not always available. In the end, the power problem (and the technology to use power) went unsolved.
3. Because no one was familiar with the machinery, the machines were not installed properly, and they often vibrated (according to a report from the Mie spinning plant). Among other problems, the vibrating led to defective goods, and, as engineers were in short supply, machine repair and maintenance were neglected, which resulted in extremely poor production. The idea arose to employ foreign engineers, but none of the plants could afford to.

Referring to a specific case, at the Mie spining plant, the fly frames and the spinning machines were manufactured by different makers, and the speed of work on the two was not balanced. This fundamental lack of planning coordination resembles the current situation in many developing countries.

The total number of plants established by the government reached only 17, and when, after about 10 years, the government withdrew its support, only 3 managed to survive. These three evolved into the two large textile concerns of Toyobo and Kurashikibo. By working to overcome the technological weaknesses described above, they achieved a leading rank among rising new industries. These plants were also successful in management reform, which was directly connected with the resolution of the technological problems.

Despite the failure of the model plants, in 1881 a plant (the Osakabo plant) was established independently of the government plan by private financing after a carefully conducted feasibility survey of the location. The plant started with 15,000 spindles, using 150 hp steam-power. A youth named

Yamabe Kentaro, studying in England, was sent to a plant in Lancashire for training, while the men who would later become the leading engineers under him were sent to government plants. The machines were installed under the guidance and control of a man named Needle, a British engineer, and Saito Kozo, of the Osaka Mint Bureau. These two had learned much from a thorough study of the errors made at the government-operated plants.

One might ask at this point why 2,000 spindles were decided upon as the standard number at the government-operated plants. Previous studies do not provide a convincing answer. Presumably, it was impossible for the engineers involved in the project to conceive of a 10,000-spindle factory. They had not seen plant operations in any Western industrial country and thus probably lacked sufficient knowledge of the latest methods of engineering.

In short, the role of government in the spinning industry was not positive, and even if we admit its role, it should be regarded as limited.

The Case of Silk Reeling

As with the railways, a foreigner living in Japan (a Dutchman, or, according to some, a Frenchman) filed an application to build a silk-reeling plant. As a result, the government hastily decided to establish such a plant itself. Fortunately, it was able to hire Paul Brunner (1840–1908), who, over a long period, had earned respect as the "great master." Most of the country's technological success in silk reeling should be attributed to him.

For the Meiji government, there was only raw silk, besides its gold, silver, copper, and coal exports, that Japan could export to pay for its huge amount of imports. However, Japanese raw silk was produced with an emphasis on its white colour, lustre, and softness; its denier was inconsistent and so its commercial value in Europe was low, where it could be used only for woof in weaving. Because it was necessary to adopt Western reeling technology to produce hard twisted and uniform thin thread, the government imported plant facilities from France; French engineers and skilled workers were also hired to provide guidance. This was in 1872, and the location was a small castle town, Tomioka, in Gumma Prefecture.

In addition to French technology, Italian technology was also imported. But it took 20 years before these technologies, which had been introduced almost at the same time, could be cross-bred to form a system of technology most suitable for Japanese conditions. Once formed, Japanese reeling technology became stabilized and its market moved from Europe to the United States, where it could compete with low-priced Chinese and high-quality Italian silks. Its international position was thus secured.

Besides mastering the Western technology of reeling, the Japanese provided technological innovation by improving the unevenness of the thread through standardization of the cocoons and by achieving a thinner thread through pre-treatment. Furthermore, a series of improvements was made to the cultivation methods of mulberry and the raising of silkworms. In the

1930s, the technology was at its peak; then came World War II and the immediate onslaught of stagnation in the industry.

One significant aspect of the government operation at Tomioka was that it employed women from all over Japan and trained them—over a period of two to three years—in the entire production process. As a result of their extensive training, when they returned home, they became teachers and directly contributed to the diffusion and development of new technology throughout Japan.

Especially notable were the intelligence and great skilfulness of these workers. This is evident from the *Tomioka Diary*, written by one of the women workers at the plant, Wada Ei (1857–1929), in the days, it might be noted, before compulsory education. The diary indicates that the workers were highly knowledgeable, which, added to their skills in traditional technology, enabled them to master and begin to pass on the new technology in a matter of just a few years' time. Not insignificantly, many of the women at the Tomioka plant, it might be mentioned, came from former samurai families.

Second, as Wada wrote, in establishing the new technology in other areas, such drastic capital-saving measures as the substitution of wood for the copper, iron, and brass used at the Tomioka plant, wire for glass, and an earth floor for the brick were adopted. Investment in the Tomioka plant amounted to ¥200,000, equivalent to ¥2 billion today; a plant established at Matsushiro started with only ¥300.

The boiler used at Matsushiro had been designed by a sailor and was built by a copper-pot artisan; the pipes were made by a gunsmith, and the wooden gears by a maker of spear shafts. It was a full mobilization of traditional technology.

After much effort, machines were built and made operable, a stunning achievement. Despite that the equipment was a crude imitation and had poor output, the mere ability to manufacture this equipment revealed a formidable engineering ability among the workers. This means that the technological gap between Japan and the advanced countries at the time (disregarding the principles of engineering) was not desperately wide. And yet, to many of those who thronged to the Matsushiro plant to learn how to set up similar plants in their towns and villages, even the relatively crude hand-crafted machines at Matsushiro appeared needlessly luxurious.

The example of Matsushiro makes evident that management in the silk-reeling industry followed rationalistic management principles, with a keen sense of evaluation of technology. The managers were practical leaders, who worked on the shop-floor designing and manufacturing machines of their own and enlarging the scale of operations by repeatedly investing their profits. This was in sharp contrast to the cotton-spinning industry, in which many of the managers were politically connected businessmen.

On the other hand, management in the silk-reeling plants did not hesitate to coerce the young female workers in to accepting their ethic of self-

sacrificing diligence. In the plants, a wage system was worked out according to rank, in which the lump-sum amount of wages was fixed and workers had to compete to take a greater piece of the pie. Based on their abilities to conserve raw materials and to reel a better-quality yarn in greater quantities, the workers were ranked first or second class, and wages were determined by these rankings (Nakamura 1952).

Regarding the government's role in the technology for the silk-reeling industry, it was important, but only for a short period at the very beginning, the initiative for development being held by private business groups. Legislative measures against the harsh working conditions and hygienic problems always lagged, and in the administration of the law, a higher priority was put on protecting private property than on protecting basic human rights. In labour disputes, the government authorities continually opposed labour.

How Japan Was Able to Catch up with India—A Subject for Dialogue

For the Japanese cotton industry, India was a stiff competitor and a technologically more advanced country. Here the issue concerns not only the formation of international competition around a technology but also its influence on decisions regarding the priorities in development policies. Some advocates give first priority to light industry, especially the textile industry. Our position is that no industrial policy is equally applicable to every country, and so the discussion here is meant only to further our dialogue without imposing hard and fast conclusions.

Management Scale and Technology

A simple comparison of Japan and India reveals there was no restriction on expansion and development in the Japanese cotton industry, in contrast with the situation in Great Britain and India (Yonekawa 1981). There were only economic limitations. Thus, for example, in the Japanese cotton industry, there was a 24-hour, 2-shift (day and night shifts) operation system in effect, and the high profits earned from this system were reinvested. Before 1911, no legislation existed to protect the workers.

This, then, enabled Japanese enterprises, the initial scale of which was much smaller than that of the spinning shops in Bombay, to catch up rapidly.[42]

According to Kato (1979), a shift from the mule to the ring spinning machine was carried out simultaneously in Japan in all large factories, contrary to the situations in England and India, where both types were in use. In India, there was the big factory at Tata that converted to the ring at an early stage, but in India as a whole, the mule spinning machine was in the majority and the ring machine was auxiliary.

The question regarding types of spinning machine relates to the problem

of management. Tata was exceptional because, from the beginning, it was opposed to the proxy management system (foreign-owned, locally managed enterprise system); whether we may point to that as the reason for Tata's early conversion to the ring spinning machine is uncertain, but it does appear that India's proxy system by nature was passive toward technological change. Indeed, the switch to the ring spinning machine in India was slow, and, in comparison to owner-managed operations, the proxy system was not sensitive to technological change.

On the other hand, when Japan was making frantic late-comer efforts to master the new technology to replace imports with domestic products, because (1) the ring spinning machine required fewer skills to operate and (2) domestic demand was mainly for low-count yarns, the ring spinning machine was most suitable: it was not only the most advanced, it was also the best suited to the market and working conditions in Japan at the time.

When the large-scale factories, specialists in spinning low-count yarns, started also to produce woven fabrics—at the time of their entry into the Korean and Chinese markets—a development in the technology of cotton mixing was introduced; this change was accomplished through minor operational improvements in the functioning of the ring machine for spinning middle- and high-count threads and for weaving. The technology of mixing had thus developed into a Japanese specialty.

Trading Companies and the Technology of Cotton Mixing

While the technology for cotton mixing was also being applied in other countries (especially India), Japan, which could not produce high-grade raw materials, had originally developed this technology and established it as a technology for making use of inexpensive cottons. Table 3 illustrates the process of spinning and weaving high-grade fabrics by changing the ratio of the cotton mixture, depending on the characteristics of the ring spinning machine.

From the table one can infer why it was that in a few years' time the cotton-spinning industry stopped using Japanese cotton except in producing goods that made the best use of the particular nature of Japanese cotton for dyeing.

The development of cotton mixing had another aspect, the links with other industries.

Unlike the cotton spinners in Lancashire, who had no need for business organizations or related activities for purchasing raw cotton and who could concentrate all their energies simply on spinning, in Japan—and this was so up until the Second World War—there was a close relationship between the trading companies and the cotton industry; this relationship functioned in such areas as the import of raw cotton, credits, and in sales of manufactured cotton yarn and woven fabrics (Kato 1979).

A relationship involving specially contracted spinning between trading firms and manufacturers developed. In this arrangement, the trading firm supplied a certain volume of raw cotton that it secured through direct pur-

Table 3. Fabric grade and the ratio of cotton mixture

Counts	Japanese middle grade	Cotton of other countries
–10	Almost all	Almost none
10–13	30% to 70%	30% to 50% (Indian and Indonesian cottons)
14–18	30% to 50%	50% to 70% (same as above)
20–24	10% to 20%	80% to 90% (Indian high grade, Indonesian and American middle grade)
28–		100% (higher than American middle grade)
Over 50		100% (American high grade)
Over 60		100% (Egyptian low grade)
Over 80		100% (Egyptian high grade)

Source: From Sambe Sei'ichiro, ed., *Meiji shoki ni okeru wagakuni menka seisan no chōraku* (Decline of cotton production in Japan at the beginning of Meiji) (Tokyo, 1947).

chase at the place of production, and sold the manufactured goods. This sort of relationship between large trading firms and large spinning factories typified the industry, and here we see the prototype of the function of a Japanese trading firm. There were also secondary and tertiary linkages, typified, for example, by ships engaged in the transportation of raw cotton from all over the world.

Subdivision and Rotation in the Production Process

Regarding the production process, many specialists stress the 24-hour operation of the cotton spinning mills as important, but I contend that skill formation through the rational subdivision of production work and personnel rotation was just as important.

Although the massive employment of unskilled workers and long hours defined factory labour at the early stage of industrial development, the tasks were simple, and versatile, skilled workers did not come about under these circumstances alone. The technology of cotton mixing entailed operating machines that required skills, and, with woven fabrics, a higher quality required a higher degree of skills.

Consequently, management inevitably adopted measures for the development and formation of skills. One such measure was the rational breakdown of the major production processes into several subdivisions, which then made it easier to quickly master the skills at each subdivision. Workers moved from one subdivision to another, which enabled them to master the technological knowledge and skills needed for each major production process. This was the Japanese method of skill formation.

Hosoi Wakizo (?–1925), who left a detailed record of the life of textile workers entitled *Joko Aishi* (The sad story of women workers, 1925), and

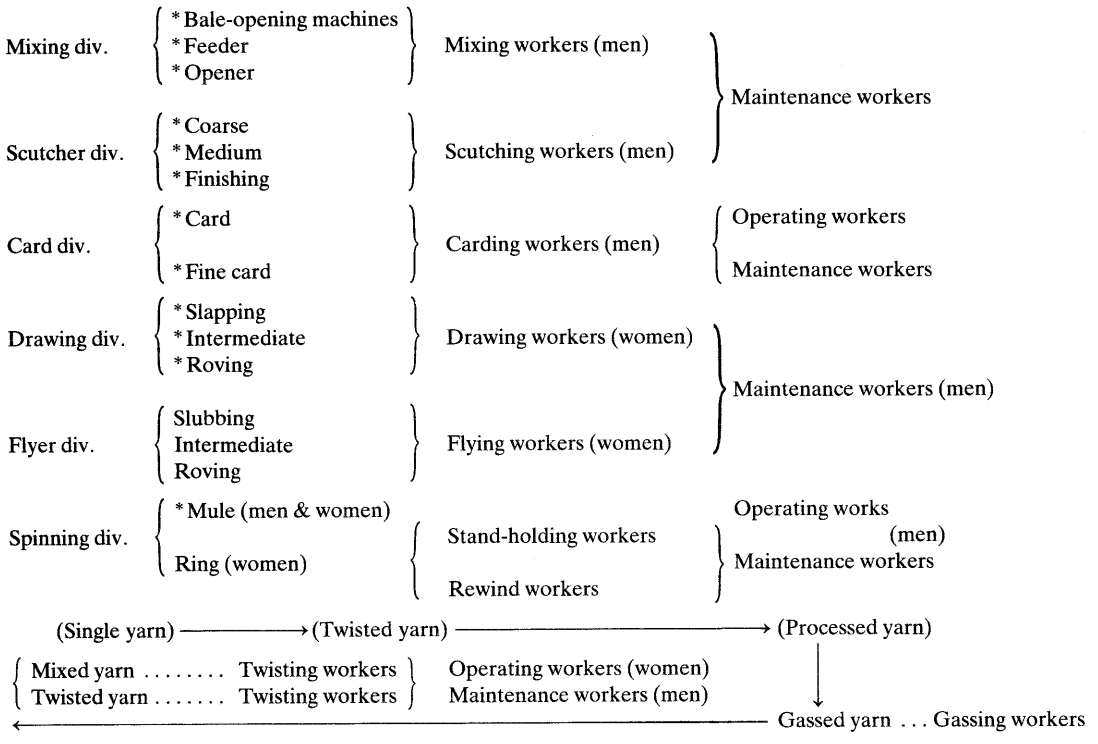
who worked the reel in mule spinning, wrote that around the time when the Japanese textile industry established its international position, there was a dual structure in wages and technology corresponding to plant size and operational scale. Moreover, there were important differences in the type and scale of operation between exclusively spinning plants and spinning and weaving plants. Hosoi pointed out that workers in large and small plants had lost the interchangeability economic theory requires as a premise. Hosoi himself was a single-skilled worker in a large-scale plant. He described the production process as in the chart on pp. 140–141.

This description pertains only to the spinning division as Hosoi saw it. Actually, there was a much greater division of work. If the division in weaving (8 major processes, 18 subprocesses, and 18 different types of jobs), their auxiliary processes, and the chief supporting divisions (motors, repair, construction, maintenance) were added to those above, the entire plant consisted of 50 to 70 types of jobs (or subprocesses).

Part of the chart came from a report entitled *Nihon no kasō shakai* (Lower strata of Japanese society), by Yokoyama Gennosuke, published more than a quarter-century before Hosoi's report; the major divisions of Yokoyama's chart are marked in the above chart with asterisks to clarify the difference between the two. Yokoyama did not touch on the auxiliary divisions (or the weaving division). Although Yokoyama and Hosoi were describing two different plants, a comparison of the two charts indicates that the technological organization in large plants had been standardized by the end of the nineteenth century. Presuming that what Yokoyama referred to as the "ring" indeed was the ring spinning machine, and considering that the difference of about 30 years between Yokoyama's book and Hosoi's report was the difference between the initial stage of spinning technology and the stage of its maturity, it may be supposed that, while the ring machine itself had undergone some improvement, there were no revolutionary changes in the technology.

Toyoda Sakichi's automatic power loom was invented in 1925, the year in which Hosoi completed his report. But Toyoda's loom did not immediately become popular: In the smaller factories, there was a lack of capital for introducing the new machines, while the larger plants felt, as yet, no need for them. A sophisticated division of labour in the production process and the use of specialized (i.e., single-skill) workers had reached its development in the large factories. At small plants, according to Hosoi's technological classification, one worker was still in charge of the whole range of tasks in one division, which presumably corresponds to our implied "major process." The system of division of labour at small plants was a vestige of the mule-spinning stage.

The Osaka Spinning Co. introduced the ring spinning machine in 1886 when its second plant started operation. Major plants followed Osaka's lead, but, as Hosoi confirms, these major plants did not abandon the mule spinning machines, whose operation required a long time for workers to master. The


Mixing div.
* Bale-opening machines
* Feeder
* Opener
Mixing workers (men)
Maintenance workers
Scutcher div.
* Coarse
* Medium
* Finishing
Scutching workers (men)
Card div.
* Card
* Fine card
Carding workers (men)
Operating workers
Maintenance workers
Drawing div.
* Slapping
* Intermediate
* Roving
Drawing workers (women)
Maintenance workers (men)
Flyer div.
Slubbing
Intermediate
Roving
Flying workers (women)
Spinning div.
* Mule (men & women)
Ring (women)
Stand-holding workers
Rewind workers
Operating works (men)
Maintenance workers
(Single yarn)
(Twisted yarn)
(Processed yarn)
Mixed yarn ..... Twisting workers
Twisted yarn ..... Twisting workers
Operating workers (women)
Maintenance workers (men)
Gassed yarn ... Gassing workers

Reeling place	Reeling workers (women)	
Rewind	Rewinding	Rewinding worker
	Bundling	Reel-tightening workers (women)
*Packing	Stretching workers	

The process up to the above was the actual production process. There were also the following auxiliary divisions:

Roller shop	Roller repair workers (men) Roller polishing workers (women) Belt workers
Experiment div.	Grain testers (men) Assistants (women)
Cotton-selecting div.	Cotton-selecting workers (women)
Lubrication (men)	
Bundling (men)	
Bank making (women)	
Transportation (men)	

mule was preserved probably because of its special mechanical characteristics relating to the production of high-count yarns and fabrics made from long-fibre cottons.

At this stage, the competitor was no longer India, which manufactured low- and medium-count yarns, but Great Britain. There, a high degree of horizontal division of labour had been developed among the three divisions of spinning, dyeing, and weaving, and each plant had become smaller, and few plants were engaged in both spinning and weaving. Japan was characterized by a vertical integration on the basis of large-scale operation.

We are not in a position to judge whether a horizontal division of labour is more effective or whether vertical integration is more rational in the process from technological dependence to technological self-reliance (especially technology development).

However, we can offer an interesting example of the value of the latter approach: the success of the Japanese watch industry in moving from quartz to electronically based watches was due to maintaining a continuous production system in the plants. Considering that the principle of the quartz watch had been discovered more than 50 years ago, the opportunity to apply it was equally available to all watch manufacturers. However, in Switzerland, for instance, where the famous watchmakers have specialized in design and assembly, the mechanical watch industry has been based on a system made up of a wide range of independent, highly skilled manufacturers of component parts. As a result, the Swiss watch industry, in consequence but not in principle the most advanced in the world, was not able on its own to lead the innovation in this sector of technology.

In textile technology, as Hosoi has recorded, the textile workers undertook "50 to 70 different types of jobs," and actually even more divisions of labour. Yet it was a general practice at large plants to group the workers into "operating workers" and "maintenance workers," although it was diffcult to distinguish clearly between the two. Eventually, a precise division of labour came into force, but it was not fixed by job functions. This is noteworthy when compared with India at the end of the nineteenth century.

Technological Change and Female Labour

The conversion from the mule to the ring machine changed the labour structure from one dominated by male workers to one with female workers in the majority. The ring spinning machine required no physical strength, and wages for women were lower.

According to Yokoyama, female workers were now performing the tasks of drawing, slubbing, spinning, and reeling. The spinning division needed the greatest number of workers, and the division where the work was hardest was slubbing. The spinning industry developed subsequently depending on women workers. This industry had the potential to create a huge employment opportunity on the one hand, but, on the other, it depended on the possibility of employing massive numbers of low-waged workers. To this

end, it often located in urban areas in places near where the poor and the indigent lived. The low price of land was perhaps a factor, but the possibility of recruiting a cheap labour force was undeniably of primary concern.

Because of the low wages, often not only male workers but also their wives and young children were employed together; the men working alone was not enough to provide families the necessary support. This employment of all family members is referred to as "complete employment," in ironic comparison with the term "full employment." (These terms are said to have been coined by Professor Tohata Seiichi.)

The gruelling work and long hours at the factories caused high turnover, and recruiting additional or replacement labour from the area where a factory had been established became almost impossible once several years had passed since the establishment of a factory. Consequently, when recruitment of labour had approached its limit, companies would customarily dispatch agents in charge of recruitment to remote areas where people were likely to be unfamiliar with the reality of the shop-floor. Using three-year labour contracts and low advance money, the companies got a firm grip on their workers, most of whom, as mentioned, were women. More than 80 per cent of the labour force in all factories was recruited in this way. Urban applicants accounted for the rest. Women comprised more than 70 per cent of the total work-force.

Such was the employment structure in the textile industry. Since more than 30 per cent of women workers retired every year at the expiration of their contracts, it was necessary to replace them annually.[43] The expense of recruitment amounted to several months' wages, which the newly recruited women workers had to bear, and it was thus the same in effect as a reduction in wages. In the absence of recruitment expenses, the wage would be high by the amount thus saved; but, even this higher wage was insufficient to secure applicants in the number required.

An overwhelming majority of recruited women workers were the daughters of families engaged in agriculture or fishery who were forced to seek employment to help support their families. As a result of the terms of their contracts and their meagre advances, they were forced to live in dormitories, where they were under strict control; to prevent them from running away or being hired by another company, they could almost never leave the dormitory. Every two workers alternated shifts, one day and the other night, using the same bed continuously; this gives an idea of how harsh the conditions were.

Such conditions did not exist at all of the mills; conditions were less harsh at the Tomioka dormitory, for example; nevertheless, Tomioka had many sick women, and the Tomioka mill was the first factory in Japan to have a hospital attached to it. Women in silk-reeling work could, in the early years, recover at home during the winter season (later the situation deteriorated to the poorer level characteristic of cotton spinning).[44] Despite the development of the spinning industry and technological change, its female labour force did not benefit from improved conditions.

Hosoi claims that what tormented them most were the long, hard hours and homesickness. Their hard work at home in the fields did not prepare them for the harsh conditions of the mills, for the severe factory regime they encountered there. Therefore, despite the attempts by the companies to keep them on, many women workers returned home, often with their health irrevocably ruined.

As a result of the bad working conditions, long hours, and poor nutrition, beriberi and tuberculosis were not uncommon. Many of the women suffered from impaired hearing caused by factory noise. Their tendency to speak loudly as a result frequently brought on ridicule. Eventually a cure was found for beriberi; and, once its cause was discovered, the factories began giving the women workers a more nutritious—albeit less easily digestible—type of rice. And because they could not rest after meals, many women developed stomach trouble.

Through infected workers who returned home, tuberculosis spread so widely that it was called the national disease. According to Hosoi, the birth rate among married women workers was generally low, and the incidence of miscarriage and premature births among them was more than twice the national average; the number of births of handicapped children was also high. There was no protection for pregnant women, and the sole condition for employing juveniles was a period of compulsory education. Each factory overcame this by establishing a school attached to the factory. However, this educational component only added to the already high degree of overwork.

The Starting Point of Development

With the cotton yarn and silk thread spun by women workers at the sacrifice of their health, Japan bought warships, purchased machines, increased exports, and substituted imports with domestic goods. It achieved technological independence and survived as a sovereign nation. And for the sake of securing a "greater co-prosperity sphere," Japan ravaged Asia and damaged itself seriously. The price paid by the workers was too high.

Japanese self-reliance in technology and development after World War II was initiated with the recovery of pre-war technological development. And now, the high price that had once been paid by women workers was, after the war, paid by the Japanese people as a whole through environmental pollution.

The sad pre-war history of women workers and the post-war environmental pollution occurred because the élites of politics, administration, economy, and technology failed to concern themselves with the consequences of their arrogantly enforced "development," which cared little for the rights of ordinary people; the sole aim was urgent national development. As far as it pertains to human rights, the relation between the urgency and supremacy of development and also between development and democracy may need to be made open to criticism by foreign citizens, even though a country's develop-

ment is a matter of its sovereignty. Otherwise, the international basis of our "methodological dialogue" will have no meaning.

Before closing this section, a brief mention of the contemporary Japanese textile industry is in order. The Japanese textile industry today no longer depends on natural fibres. Although natural fibres are useful and sometimes indispensable, they have lost the importance they had before the war. Hand-woven linen, cotton, and silk cloth made of only natural fibres have become extremely high-calibre craft work.

Most of the leading textile companies in Japan today have been engaged in the research and development of chemical fibres since World War II, when Japan could not import raw materials, and have thus diversified into the chemical industry, as well as into other sectors of new technology. Japan's technological stock has prepared it to enter the most advanced fields of technology; indeed, although most Japanese are not aware of this, vinylon (polyvinyl alcohol fibre) was invented in Japan. Furthermore, the trading companies that specialized in raw cotton and cotton products have become general trading companies, serving technology transfer as a part of their activities.