The Machine Industry in the Meiji Period

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This study is an attempt to outline the evolution of Japan's machine industry prior to World War I, focusing especially on machine production for private-sector demand.¹ The reason for this special focus on machine production for private-sector demand is that previous research has concentrated on the munitions production aspect of the machine industry in this period and has thus painted a one-sided picture of the situation.

Throughout this period the representative large-scale machinery producers were the government-owned army and navy arsenals, the private-sector shipyards, and the railway factories (both government and private). Steamships were an important means of transport for military purposes in Japan, surrounded as it is by the sea, and their manufacture was given the protection of the state. The major shipyards, too, especially from the time of the Russo-Japanese War (1904–1905), were involved, under the control of the Navy, in manufacturing warships as well. As a result, a certain percentage of their business operations was taken up by munitions production.² And the

¹ Basically, this paper is a summary of the author's Meiji no kikai kōgyō [The Meiji machine industry] (Minerva Shobō, 1996); to that extent references to bibliographic sources have been reduced to a minimum.

² Opinions are divided about assessing the percentage of military supplies in ship-
shipyards not only manufactured (right from their earliest days) steam engines and working machines for use on land, along with bridges and cast-iron pipes and the like, but the largest of them, the Mitsubishi Dockyard (now Mitsubishi Heavy Industries), also embarked on the production of electrical machinery before World War I, and then moved into the production of aircraft and automobiles after the war. The second largest, Kawasaki Dockyard (now Kawasaki Heavy Industries), advanced into the production of railway rolling stock before World War I and into the production of motorcycles after World War II; along with the Ishikawajima Dockyard (now Ishikawajima-Harima Heavy Industries), which was the third largest shipyard and, right from the beginning, competing for first or second place in the Tokyo area as a producer of machines for use on land. These three enterprises have continued right up to the present day to be influential machinery makers. Another thing to remember is that the manufacture of railway rolling stock was very important militarily, so it was the recipient of state protection. And the move to completely domestic production of steam locomotives before World War I, which was a sign that the rolling stock manufacturing industry had attained a solid footing in Japan, was achieved as a result of the Railway Bureau’s policy (after the nationalization of the principal railways in 1906) of ordering rolling stock from private factories within the country and providing technical assistance to these factories.³

As long as we focus our attention on these large-scale factories of this period, what stand out are the military requirements and those areas in which the factories received state protection. And to a large extent these factors explain the origins of today’s giant machinery makers. On the other hand, in the case of almost all cotton-spinning mills and paper-manufacturing plants, which were the most representative building operations and about whether the technical guidance provided for warship construction did or did not contribute to the improvement in merchant ship construction techniques. See Yōichirō Inoue, *Nihon kindai zōsengyō no tenkai* [The evolution of modern Japanese shipbuilding] (Minerva Shobō, 1990), pp. 117–21; Shigeki Koike, “Nihon zōsengyō to shijō kōzō” [Japanese shipbuilding and the market structure], *Shakai keizai shigaku* [History of social economy] 39, no. 2 (1973); and Hisatomi Naruse, “Nihon kindai zōsengyō ni okeru ‘gunju’ ni tsuite” [On ‘munitions’ in modern Japanese shipbuilding], *Chiba Shōdai ronsō* [Chiba University of Commerce journal] 15, no. 2 (1977).

³See Minoru Sawai, *Nihon tetsudō sharyō kōgyō shi* [The history of Japan’s railway rolling stock manufacturing industry] (Nihon Keizai Hyōronsha, 1998), pp. 57–60.
types of highly mechanized factories in Meiji Japan, most of the large machines were imported items. It is for these reasons that the commonly held view has been that Japan’s machine industry was slow to develop in response to private demand and that it was nurtured for the sake of military goals as a matter of government policy.\footnote{See, for example, Kaichirō Ōishi, \textit{Nihon sangyō kakumei no kenkyū} [A study of Japan’s industrial revolution] (University of Tokyo Press, 1975), p. 17.}

This study adopts a different tack, however, and it aims at clarifying the whole picture of the machine industry in this period, by including in the picture small and medium-sized manufacturing plants and focusing on the demand in the industry as a whole and the way the domestic machine industry responded to that demand.

THE ORIGINS OF THE MACHINE INDUSTRY IN JAPAN

THE BIRTH OF THE MACHINE INDUSTRY

For centuries the representative forging techniques used in sword making and the casting techniques used in making Buddha statues and temple bells and the like had evolved to a high degree; when, in the sixteenth century, rifles and cannons were brought into the country, domestic production of these items began within a few years. From the seventeenth century on, however, there were no wars or disturbances on the domestic scene, hence there were no advances in the production of military weapons. Standing clocks began to be produced on the model of imported goods, but these were dependent on manual labor. As a result, the country did not see the type of development that was seen in eighteenth-century Europe, where there was development in the iron manufacturing industry for the sake of producing large cannons, a development that was the technical prerequisite to the industrial revolution, and there was a great deal of use of machine tools in the production of military weapons and clocks.

Using machine tools in the manufacturing of machines began in Japan with munitions production. In the middle of the nineteenth century Japan was forced into opening the country under military pressure from the West, and as a result the demand for arms, especially arms like those used in the West, increased; this was accompanied by a vigorous growth in production. In the midst of this
activity, the Tokugawa government imported its first machine tools in 1858 and started using them in the Nagasaki Dockyard (which had been built with the help of the Dutch navy) to manufacture and repair the engines used in steamships. In addition to these operations, advances were made in casting techniques through the manufacture of cannons, the repair of engines in steamships for military use, and the manufacture of small steamships; this was accompanied by a spread in the use of machine tools. At that time in Japan's history there were around 300 feudal lords who were under obligation to provide military support; of these, more than 30 of the comparatively more powerful lords were engaged in producing weapons in their own fiefs. The fact has not been given much attention in previous studies, but it is believed that the production of Western-style small arms that was carried out in different parts of the country on the widest scale and that involved large numbers of men, was an important factor in the formation of a large pool of mechanics, which in turn was a prerequisite to the widespread development of machine production at a later period of time. Unlike what was being done in the West, in Japan the manufacture of Western small arms usually did not involve the use of machine tools; for the manufacture of gun barrels the artisans made use of the techniques they had mastered earlier in the making of gun barrels for matchlocks, but they needed to learn new skills and techniques for manufacturing firing mechanisms and rifling gun barrels. Also, in order to increase the quantity of goods produced it was necessary to create a system of specialization that could include even people who were not highly skilled. These techniques, skills, and greater experience were dispersed to the local feudal lords' home bases either through the lords' hiring of skilled machinists from Edo (or sometimes from Nagasaki) or through sending their local skilled workers to Edo. Working in the Tokugawa government's own small arms factories and those of local feudal lords, there were, besides traditional gunsmiths, ordinary blacksmiths and other laborers hoping to gain skills, and in the course of their work they were acquiring (and improving in) the new skills of ironsmiths.

After the civil strife that took place in 1868 and 1869, the various clans were abolished in 1871 and clan warriors were replaced by a unified army. This meant the provision of armaments could be scaled down. Since there were ample Western-style weapons in stock, the fac-
Stories of feudal lords in different parts of the country were closed, and for over ten years even the army arsenal of the new Meiji government was smaller in scale than the old Tokugawa government's munitions plant. The result of this situation was that many technicians changed jobs and joined non-munitions manufacturers. The manufacture of arms from the end of the Tokugawa period through the first few years of the Meiji period would thus produce a large number of technical experts and skilled workers and send them forth into areas that had nothing to do with munitions production.

There was another stream of machine manufacture that began at the end of the Tokugawa period, and this came as a response to a demand for repairing the foreign ships that visited Japan and a demand for manufacturing and repairing the various machines of foreigners resident in Japan. It also was begun by the foreigners that had come to Japan. From 1859, when two English shipwrights arrived in Nagasaki, a shipbuilding industry and a machine industry were built up in the open ports of Nagasaki, Yokohama, and Kobe. They also met Japan's government-sector and private-sector demands. These factories and shops, which all had numerous Japanese working under foreign technical experts and skilled workers, made it possible for Japanese workers to sharpen their skills.

**GOVERNMENT-OWNED BUSINESSES, AND FOREIGNERS**

After the opening of the ports, foreign ships visited Japan in increasing numbers; also, by 1868 over eighty ships were imported by the Tokugawa government and individual clan domains. The result was a sharp increase in the demand for ship repairs throughout the country. After the Meiji Restoration in 1868, the new government had to take responsibility for the increasing demand for machines in other fields.

On the other hand, neither the Tokugawa government nor the Meiji government wanted the shipbuilding factories and machine shops run by foreigners to become dominant in their respective business fields in Japan. So the Tokugawa government built a shipyard that included machine shops, and the Meiji government took over this shipyard. One of the purposes for which the Japanese government extended its own shipyard was so as to put restraints on foreign management. For example, the Tokugawa government rejected a plan by the for-
eigners to build a dry dock in the vicinity of Yokohama because the government itself was planning to build a dry dock in the Yokosuka shipyard that it had been building since 1865 with the assistance of the French navy. When this dry dock was opened in 1871, a number of machine shops and shipyards in Yokohama run by foreigners went out of business. The Yokosuka shipyard would be placed under the control of the Japanese navy in 1872, but even after this it continued to function as a repair facility for private-sector ships until the construction of a private-sector dry dock in Tokyo Bay following the Sino-Japanese War. In Nagasaki a slip dock was constructed at the expense of the English merchant T. Glover, but the Meiji government feared that this would fall into the hands of the shipbuilding company Boyd & Co., which had come from Shanghai and started up business in Japan, so the Meiji government bought up the slip dock in 1869 and attached it to the Nagasaki Dockyard that it had inherited from the Tokugawa government. In addition, in Hyōgo the Meiji government bought up the machine shops that had been set up by the Kaga clan and those managed by foreigners and combined these in 1871 into the Hyōgo Dockyard.

All the government shipyards and machine shops other than military arsenals were attached to the Ministry of Public Works that had been established in 1870, and they met the demand created by all government businesses (beginning with mining), the demand for ship repairs (including the repair of foreign ships visiting Japan), and the demand created by small domestic steamships. From the second half of the 1880s, however, the costs of machine manufacturing and ship repairs were higher than those of shipyards in Shanghai and Hong Kong owned by foreigners and even than those of small and medium-sized private-sector factories that had just begun to appear within the country; also, because of the longer amount of time needed to complete construction, orders from the private sector were fewer than expected; and, finally, the mule cotton-spinning machines to be produced at Akabane and the 1,496-ton (gross tons) wooden steamship Kosuge Maru to be built at Nagasaki—the largest products of the Ministry—far exceeded the budget set aside for them; as a result of all these factors, the government shipyards and machine shops were

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5 Hiroshi Nakanishi, *Nihon kindaika no kiso katei, jō* [The basic process of Japan's modernization: Part 1] (University of Tokyo Press, 1982), pp. 221–25.
running at a loss. The government was pursuing a cost-cutting policy at the time, so it abolished the Ministry of Public Works in 1885, turned the Akabane factory into an arms factory of the Navy, and sold off the Nagasaki Dockyard to Mitsubishi and the Hyōgo Dockyard to Shōzō Kawasaki.

THE DEMAND FOR BUILDING AND REPAIRING SHIPS, AND THE SHIPBUILDING INDUSTRY

At the time, Mitsubishi was the largest shipping company in Japan, and it also owned coal mines and other mines. To move into the repairing of ships, it merged with Boyd & Co. in Yokohama in 1875 and built its small Yokohama Ironworks. In 1878 it cancelled the merger and moved into single ownership of Mitsubishi. Since Mitsubishi had monopolized coastal trade in those days, most of its work involved repair of its own ships. Englishmen who had been hired by Boyd & Co. were still on the payroll as technicians and accountants, however, and it was under their guidance that repair operations and accounting were carried out. Mitsubishi was not inclined, however, to make use of the Ministry of Public Works factories when it came to projects that exceeded the capabilities of its own ironworks; instead, for the repair of steamships and the manufacture of machinery for use in its coal mines it relied on Boyd & Co. and other operators in Shanghai. When it was able to lease the Nagasaki Dockyard in 1884, however, it tried as much as possible to meet its own demands at the Dockyard. Any enterprise that, like Mitsubishi, had divisions of marine transport, coal mining, and mineral mining—all of which require machinery—and also ran its own machine manufacturing operations, was guaranteed a certain market. Mitsubishi set out to make its management and technology more effective by seconding the English technicians who were managing things at the Yokohama Ironworks. Indeed, the Ministry of Public Works employed foreign technicians, but they were small in number, hampered by Japanese officials who were unaccustomed to business matters. As a result, the dockyards lacked business competitiveness even though they possessed the best of facilities. By making good use of foreigners with business experience, Mitsubishi achieved an improvement in its business content and went

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6 Hidemasa Kokaze, *Teikoku shugi-ka no Nihon kaiun* [Japan's marine transportation under imperialism] (Yamakawa Shuppansha, 1995), pp. 131–58.
on to develop into a shipyard that could compete business-wise. The transfer of the Akabane plant to the Navy was motivated by similar thinking on the part of the government, in that the plant was entrusted to a strong facility that had its own internal demand guaranteed. From this it is clear that, after the Ministry of Public Works was abolished, the government adopted a policy of handing over plants to businesses that had an internal demand. The basic reason for such a policy was that these plants did not have the solid managerial practices to match the development of their plant facilities.

The Hyōgo Dockyard was scheduled to be sold off for the same reason to a marine transport company that had been established in 1882 to be on an equal footing with Mitsubishi: Kyōdō Un'yu. But because this company merged with Mitsubishi to form Nippon Yūsen, the Hyōgo Dockyard was instead sold off to Shōzō Kawasaki personally (Kawasaki was connected with Kyōdō Un'yu and was also managing a sailing shipyard). Another individual to benefit from government sales of assets was Tomiji Hirano, who in 1876 acquired from the Navy a dock on Ishikawajima and land for shipyard use, and in 1880 a machine shop in Yokohama; his business continued to fulfill the demand for machines and military supplies in the Tokyo area.

From 1878 marine transport by small steamers, especially on the Inland Sea, thrived, and by 1884 there were a hundred such ships plying Japan's coastal waters. This represented the first demand for steam engines arising from private-sector business operations, and nearly all these ships were produced within Japan. Many of the hulls were constructed by small/medium private shipyards, but the marine steam engines were produced in Ministry of Public Works shipyards or in Kobe Ironworks, a company started by the Englishman Edward Charles Kirby. Steamships made Kirby's ironworks enjoyed the highest reputation. When a recession and excessive competition caused small-steamer transport to fall on hard times from 1882 on, Kobe Ironworks went into building iron steamships of approximately 500 gross tons, and it even took an order for a warship, but in 1883 it went bankrupt and was taken over by the Navy.

As a condition for financial support for constructing steel steamships, the government stipulated that Osaka Shōsen Kaisha (Osaka Merchant Shipping Company), which was formed in 1884 by a massive union of several shipping companies operating in the
Inland Sea, had to build those steel steamships at Hyōgo Dockyard, which at the time was still government-owned. This contractual agreement was handed over to Shōzō Kawasaki when the government sold him the Hyōgo Dockyard, and it became the earliest source of income for Kawasaki Dockyard.

Meanwhile, Edward Hazlett Hunter, an Irishman who had worked under Kirby at one time, set up Osaka Engineering Works in the name of his son, Ryūtarō, who had Japanese citizenship, and there he built and repaired Osaka trading vessels and other small steamships. Whereas Kirby’s shipyard lacked a dry dock, Hunter built a dry dock in his own shipyard in 1883, and because of this dock and the shipyard’s favorable location as the home port for Inland Sea shipping, his business flourished.

From 1886 business conditions improved, and marine transport once again thrived. The Kawasaki Dockyard business was stable, thanks to an increasing demand for repairs on steamships imported for use in marine transport in Japanese waters, but the production of iron vessels and steel vessels, which Kawasaki had once monopolized, had to be shared from 1890 with Hunter’s Osaka Engineering Works and the Mitsubishi shipyard in Nagasaki. The competition thus generated led to a drop in prices, making domestic vessels cheaper than imported ones, with the result that iron and steel vessels of up to 700 tons now began to be produced domestically. Given these circumstances, the government put into place in 1896 a system whereby subsidies would be granted for the manufacture of iron and steel vessels in the 700-tons-plus category. It cannot be denied that the shipbuilding industry was nurtured by the government through the building of shipbuilding facilities and, from 1896, the use of protective measures, but iron steamships and later steel steamships came to be built because of the development of the marine transport industry, which had developed through use of steamships that were domestically produced, principally in the Inland Sea area. What this means is that industries that developed using domestically produced machines prepared a market for more highly advanced machines.

**TWO TYPES OF MACHINE DEMAND AND MACHINE INDUSTRY**

The use of machines during the industrial revolution that evolved in
Japan from the second half of the 1880s was of two types. The first involved the introduction of large imported machines for use in the cotton-spinning, paper manufacturing, railway, and similar industries, in which attempts were made to perform as much as possible exactly the same operations as in the West. These were the transferred industries. The second type involved traditional industries in which for the most part machines that had been produced domestically were introduced into the production process and partial mechanization was attempted.

Corresponding to these two types of use were two types of machine industry. The sector that met the demand of the transferred industries consisted of large, independent factories best represented by former government-owned factories and factories attached to the transferred industries. In these factories were carried out the maintenance and repair of the principal imported machines; for example, the cleaning and repair of the bottoms of large steamships in shipyards that had docks, or the fitting out and repair of steam locomotives in railway factories. In them, also, were produced peripheral machines and tools, such as small pumps or, in the case of the railway industry, freight carriages and passenger carriages. Then, from the 1890s, some of the large factories began experimenting with manufacturing the principal machines.

Meeting the demands of the traditional industries, on the other hand, was the small/medium machine supply sector, which manufactured the kinds of machines needed for mechanization in those industries. Most of these factories were small or medium-sized; making up the core of these factories were workshops run by individual artisans who had acquired the skills of the modern machine industry by working in large factories and who then had left to set up their own factories.

Most of the factories attached to such transferred industries as the railway industry were active in a sector that was purely transferred-industry related, while most of the small or medium factories were active only in the small-and-medium machine supply sector. But the relatively large independent factories did work for both the transferred and the traditional industries, with markets that straddled both sectors.

There were also two types of machine industry seen in terms of their location: the large-city machine industry and the regional
machine industry. From factories located in such large urban areas as Tokyo, Yokohama, Osaka, and Kobe, machines of all types were supplied to all parts of the country. The regional machine industry, on the other hand, evolved in close proximity to places where there was a demand for certain kinds of machines; the manufacture of machines for use in the coal mines of northern Kyūshū is a typical example. Sometimes these places in close proximity were the large cities, however; thus there developed a regional machine industry that met the needs of factories in a given large city or its environs, such as the manufacture of power looms for use in areas around Osaka or the manufacture of oil motors for use within the city limits. They served for generating power in small factories and for powering river boats.

**MACHINES FOR USE IN COAL MINES**

In the Miike Colliery machines manufactured in factories belonging to the Ministry of Public Works were used until the Ministry was abolished in 1885, after which, under Ministry of Finance and then Mitsubishi management, a switch was made to the latest in large machinery imported from Western countries. In other words, the use of machinery followed the pattern of the transferred industries. The fitting out of its affiliated factory went ahead, meanwhile, and there they produced auxiliary machinery and tools, but in 1894 the factory was enlarged with a view to manufacturing Davey pumps, which were the principal imported machines. In 1893 the government-owned Kobe Railway Factory would build the first steam locomotive to be made in Japan; in 1896 the Shibaura Factory in Tokyo would build a 1300-horsepower three-stage-expansion steam engine for use in cotton-spinning mills; in 1898 the Mitsubishi Dockyard would build a 6,172-gross-ton steamship, the *Hitachi Maru*. During this part of the Meiji period the production of epoch-making machine products modeled on Western products followed in quick succession. But because repairs and other operations that were the mainstays of the transferred industries took precedence, especially in the case of the affiliated factories in the transferred industries, the manufacture of such items was carried out during time left over after repair jobs were done, and so the start of manufacturing did not always directly lead to continuous production or the replacing of imports. Thus, at the Miike Colliery, for example,
even though the plant was enlarged, no Davey pumps were ever manufactured, simply because of so many demands by the Colliery's other operations.7

In Chikuhō in northern Kyūshū, however, steam pumps were in continuous use from 1880 on, following several trial-and-error experiments. The Chikuhō coalfield had abundant reserves and the coal bed was shallow, but a large amount of water seeped into the field, thus slowing down mining operations. After 1880, however, the use of steam pumps enabled the miners to pump out the water, so that development went ahead more smoothly, and numerous operators who combined the pumps with the use of winding engines (hoists) for carrying the coal out came into the business. At the time, such machines were first imported and later manufactured in Nagasaki and Kobe, but from 1887 small factories were built in the Chikuhō region. Most of these factories were started by artisans who had gained experience in Nagasaki or one of the large cities. In 1897, 697 pumps were known to be in use in Chikuhō; only four of these were Worthington pumps, all the rest being “special pumps” (thought to be imitations of Tangyes of Birmingham products, and most of them believed to have been made locally). The 99 verified winding engines were produced in factories in such nearby cities as Saga, Fukuoka, and Moji; the great majority of machines could be acquired right there in the northern Kyūshū area. In the latter half of the 1890s the Kōbukuro Factory (established through joint funding by local colliery owners) hired engineers who had graduated from higher technical schools and then began to supply high-grade machines, and the factory affiliated with the Miike Colliery also began to supply high-grade machinery.

THE MANUFACTURE OF BOILERS FOR SILK-REELING MILLS

The silk-reeling industry that was carried on within mills (as opposed to individual residences) acted as the principal market for machinery from the 1870s on. The working gear used in this industry consisted of ceramic pots, wooden frames, and similar simple items that involved traditional technology, so the operation of unwinding the

7 Yutaka Kasuga, “Mitsui zaibatsu ni okeru sekitangyō no hatten kōzō” [The structure for development of the coal industry in the Mitsui zaibatsu], Mitsui Bunko ronsō [Mitsui Bunko journal], no. 11 (1977), pp. 147–49.
silk threads from the cocoons was done by hand. So the work that involved
the machine industry was mainly the production of boilers and pipes
to supply heat for boiling and keeping the cocoons warm until they
were unwound, as well as the production of shafts for transmitting
motive power generated by waterwheels and/or human effort. In the
beginning it was gunsmiths and the like who manufactured the
pipes, while the shafts were wooden, but in a few years these were replaced
by imported pipes and iron rods. The chief items manufactured
domestically were the boilers, and then later steam engines for gener-
ating power. In Nagano Prefecture, the site of a thriving mill-based
silk-reeling industry, copies of imported boilers or boilers manufac-
tured in Tokyo or Yokohama were used in some of the large mills,
but most of the mills used boilers made by applying traditional tech-
nology. From 1873 boilers that had cast-iron cauldrons or riveted copper
plating were used in mills employing up to 20 or 30 silk reelers; by 1879 there were more than 150 boilers in use in silk-reeling mills.
During the 1880s use of boilers made of imported thin sheet iron (one-
eighth of an inch) and modeled on Cornish boilers was widespread,
and these were used in mills employing up to 50 silk reelers. In the
latter half of the 1880s, when the number of mills using boilers had
risen to around 400, compound Cornish and multitubular boilers incor-
porating imported fire tubes were used in mills employing up to 200
people. These were items that had been developed by local opera-
tors using imported boilers as models to work from. Almost all of the
silk-reeling mills in Nagano Prefecture were of a scale that matched
the scale of locally produced boilers; as the latter grew larger, the mills
also grew larger. In most regions outside Nagano Prefecture, boilers
were brought in from the large cities at a higher cost than what was
available in Nagano. Even in Nagano, however, when steam motors
began to replace waterwheels around 1900, such motors were at first
supplied from machine shops located in Tokyo or other large cities.

The Chikuho coalfields came to produce more than half of the coun-
try’s coal in the early twentieth century; in mill-based silk-thread pro-
duction, Nagano Prefecture was producing forty percent of the
domestic product in 1891.8 While it was the transferred industries of
cotton spinning and the railways for which, in the form of joint-stock

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8 Kanji Ishii, Nihon sanshigyo-shi bunseki [An analysis of the history of Japan’s sericul-
ture] (University of Tokyo Press, 1972), p. 198.
companies, most funds were collected and large-scale investment was made in Japan’s industrial revolution, the principal machinery used in these industries, including the rails for railways, were imported—even the cotton used in the cotton-spinning industry was imported—so that development in these industries brought about import surpluses, and it would have been impossible to rely only upon these industries to continue the country’s industrial development. Traditional industries like the silk-reeling industry and the coal-mining industry not only were responsible for a part of Japan’s industrialization by their development of factory-based production or capital-based production, but also, through their acquisition of foreign currency from exports, promoted Japan’s industrial revolution by making it possible for even the transferred industries, which were dependent on imported machinery, to continue developing. And what contributed in large measure to the development of these traditional industries was the domestic machine industry, first and foremost the regional machine industry that developed in the heartlands of these industries.

DEVELOPMENT OF THE MACHINE INDUSTRY AFTER THE RUSSO-JAPANESE WAR

The Russo-Japanese War of 1904–1905 was followed by great advances in both the use and the production of machines. Behind this development lay the general economic development of the country and the expansion of the machine industry as a result of munitions production during the war. The number of workers employed in the military arsenals during the war stood at more than 90,000, but by 1909 this number had fallen to 65,000; some of those who lost their jobs took up work in small/medium factories or started up their own businesses. Private-sector factories that had been engaged in the production of military supplies also had to find ways to make use of the facilities and machinery they had built up or brought in during the war, in producing items for general consumption. Just at this time, too, there were more engineers graduating with higher engineering education, and these started taking up employment not only in the

9 Naosuke Takamura, Nihon shihon shugi-shi ron [On the history of Japan’s capitalism] (Minerva Shobō, 1980), pp. 30–31.
government factories and large private factories that were the destinations of most earlier graduates, but also in the factories run by small/medium business concerns. This resulted in a certain amount of progress being made in the direction of domestic production of machinery used in the transferred industries and a conspicuous spread in the use of machinery in the traditional industries at the same time. In addition, in those traditional industries in which the introduction of machinery had already been far advanced, the demand for machines resulting from the development of those industries tended to switch to higher-grade items, and this, together with the eager introduction of electrical machinery, brought about changes in the demand for, and production of, machinery.

In the next few paragraphs we can look at the switch to domestic production of cargo ships in relation to the transferred industries sector and the power loom and the internal combustion engine in relation to the expansion in the use of machinery in the traditional industries. In the process we shall see the changes in machinery demand, taking the machines for use in the coal mining industry as an example, as well as changes in the construction of power looms and internal combustion engines, to conclude to the appearance of a new type of machine industry.

THE SWITCH TO DOMESTIC PRODUCTION OF CARGO SHIPS

After the Russo-Japanese War both Mitsubishi Dockyard and Kawasaki Dockyard engaged in manufacturing oceangoing cargo-passenger ships, and by doing so achieved domestic production of such vessels. Nevertheless, such production was not profitable, at least not for Mitsubishi. The reason was that, even though the companies may have had the technology and the equipment to build ships, it was difficult to make them competitive, business-wise, with imported ships. This problem was made very clear from 1910 on, in the form of cargo ships being imported on a regular basis because cargo ships were being given relatively low government protection. To deal with this state of affairs, the companies used cheap steel materials domestically produced in government iron foundries that at last were of usable quality; they also chose economical types of ships that suited the scale of the shipyards; and, finally, they worked hard to improve cost control and the work efficiency of their factory hands. As a result, just prior
to World War I, domestic orders for newly built cargo ships became the rule rather than the exception. Because domestic production of warships and cargo-passenger ships was the general rule after the Russo-Japanese War, domestic production was readily achieved in all varieties of vessels. With this amount of development behind it, the shipbuilding industry in Japan would make rapid progress during World War I.

Meanwhile, Osaka Engineering Works, a business under individual ownership, and the Yokohama Machine Engineering Company, a business that dealt chiefly with the repair of foreign ships visiting Japan and that was the only one owned by a foreigner, were both put under the jurisdiction of Japanese shipping companies during the world war, thus bringing to an end the line of foreign owners running such businesses in Japan. In order to give precedence to the building of their own ships, the shipping companies had bought out shipyards. Thus the development of Japan’s marine transport industry as a market was responsible for the end to foreign ownership.

**THE SPREAD OF POWER LOOMS AND OIL ENGINES**

Textile manufacture had been carried out on handlooms with flying shuttles, but the introduction of power looms was proceeding in all parts of the country. There were only 20,000 power looms in the country in 1906, but by 1914 this number had risen to 120,000. Since imported power looms were expensive and also were not suited to making narrow cloth, attempts were being made from the earliest years of the Meiji period to develop power looms. It was Sakichi Toyoda who first succeeded in making a practical power loom in Aichi Prefecture in 1898. His loom was suited to making narrow white cotton cloth, but around the time of the Russo-Japanese War power looms suited to the weaving of local cloths were being developed and produced. The principal regions were Hamamatsu in Shizuoka Prefecture, Nagoya in Aichi Prefecture, Osaka, and Hiroshima (for cotton cloth), and Kanazawa in Ishikawa Prefecture, Tsuruoka in Yamagata Prefecture, and Kawamata in Fukushima Prefecture (for silk fabrics). Besides production of patented goods under license in other regions as well, imitations were made in all parts of the country. These looms used wood for the frameworks and some iron parts here and there in the machines.

Internal combustion engines also had begun to be produced from
1895; these were imitations of imported models. The production of such engines spread among small and medium iron foundries after the Russo-Japanese War because it was very well suited to such small-scale manufacturers. In 1909 production at 96 factories can be attested to. The engines were in wide use as convenient sources of the motive power needed to introduce machines into areas in which machines had never been used before—for example, in order to introduce machinery into small and medium factories, or to introduce pumps into agricultural operations. The spread of electric power in the 1910s put a dent in the demand for such machines on land, but their use on fishing boats proceeded apace, and they contributed to greater use of such power in the inshore fishing industry.

A SUBSTANTIAL CHANGE IN THE MACHINE INDUSTRY SERVICING COAL MINING

The Chikuho region, like other coal mining regions in Japan, witnessed an expansion of coal mining as a result of advances in digging methods and a concentration of enterprises in the coal mining industry. At the Miike Colliery the company began using electric machines in 1901 in an effort to avoid the inefficiency of conducting steam into the pits by means of long iron pipes; once turbine pumps suited to the use of electric power were introduced in 1906, the use of electric machinery spread to coal mines throughout the country. In the old systems using steam, steam generated in a number of boilers was conducted through iron pipes to winding engines and a large number of pumps, so that the capacity of individual machines was not very great; these machines (except for large winding engines) could be manufactured in small/medium factories. But once electric power was put into use, it became more difficult to make key machines such as the large steam engines and generators needed for generating electricity, or electric motors (which required an understanding of electricity), or turbine pumps (which required a knowledge of hydro-mechanics) in local factories on the basis of the technical skills possessed by local factory workers. At the same time, such expendable parts as gears and the wheels of coal wagons, which had been made from pig iron castings in the small/medium factories, came to be replaced by steel items. As a result, even in the Chikuho region the developed coal mining industry came to rely on products from large factories and steel mills, or on imported items. In these conditions, the
Kōbukuro Machine Works in Chikuho, which had been the backbone of that region’s machine industry servicing the coal mining industry, went on to extend its operations to service a nationwide market for coal mining machinery. Similarly, Taniguchi Ironworks in Saga became a specialized manufacturer that concentrated on machinery for use in coal pits and on cast-iron pipes. These two companies were exceptions, however; the operations of other small and medium factories in regional Japan stagnated.

In 1909–10 two new factories appeared on the scene in the industry. They were Karatsu Ironworks, which had developed from a factory affiliated with the Yoshitani Colliery in Saga Prefecture, and the Hitachi Manufactory, which had developed from a factory affiliated with the Hitachi Mine in Ibaraki Prefecture. Both factories were the result of the investment of funds from coal and mining operations, and in both the main initiatives came from technicians who had graduated from universities and who had accumulated practical experience in the machine industry. They both produced electric machinery and mining machinery for use in their companies’ own mines and for sale nationwide. The former concentrated its efforts during World War I on the manufacture of machine tools, and it grew into one of Japan’s top machine tool makers. The latter concentrated its efforts on electric machines and became a leading electric machine maker.

Mitsubishi and Mitsui, on the other hand, which had long been producing machines for their own companies, had imported machines and introduced technology from overseas companies, and this enabled them to produce domestically the majority of such products. Mitsubishi Electric and Mitsui’s Shibaura Factory would later go on to develop as makers of electric machines and power-generation engines, but a factor behind their development was the fact that in their early days they had markets for such products within their own companies.

**UPGRADING POWER LOOMS AND INTERNAL COMBUSTION ENGINES, AND THOSE RESPONSIBLE FOR THIS**

A shift in demand for better-grade machinery similar to what occurred in the mining industry also occurred in regard to internal combustion engines and power looms. Internal combustion engines
of greater reliability were sought for use in fishing boats, and a
demand arose for power looms that were not restricted to narrow tex-
tiles but could also manage broader fabrics. At a time when large num-
bers of these two types of machines were being supplied, some of the
comparatively financially better off users began to think of ways to
achieve better products than their competitors. The engines power-
ing fishing boats determined the number of fishing expeditions that
could be made and whether fish were caught or not; similarly, as the
introduction of power looms progressed and narrow fabrics began
to flood the market, attempts were being made to move into broad
fabrics, which were the mainstay of export trade. The companies
that met these demands were, for internal combustion engines,
Niigata Engineering Works and the Ikegai Manufactory, and, for
power looms, Toyoda Loom Works, which produced broad-fabric
power looms from 1909. What enabled these companies to develop
these improved models was the introduction of parts-interchangeability
production. This made the internal combustion engines more reli-
able, and it made it possible to manufacture power looms that were
entirely of iron and hence more practical (narrow power looms did
not have to be made entirely of iron). Both Ikegai Manufactory and
Toyoda Loom Works employed Japanese technicians, but they also
welcomed guidance from the American technician Francis, while
technicians were also the prime movers at Niigata Engineering
Works, an offshoot of a Nippon Oil Company factory.

The machines produced by these businesses were not, as in the case
of machines for the traditional industries, of lower quality than
imported items or simplified versions adapted to Japanese condi-
tions, but products that could compete with imported goods. In the
development of Toyoda's wide-fabric power looms, technicians from
companies in the transplanted industry of cotton-spinning also
cooperated, and they chose to use these products instead of the pre-
viously imported broad-fabric power looms in their own industry's woven
cloth sector. Similarly, from 1905 on, Ikegai Manufactory made
machine tools in a form that allowed for parts interchangeability, and
these, along with the machine tools of Karatsu Ironworks, began to
be used in factories that till then had been using only imported
machine tools. At this stage we find a convergence of the trans-
planted industries and the traditional industries, which till this point
had been clearly separate machine markets. It was here where the two markets met that a new machine industry was born.

CONCLUSION

When we examine the machine industry from the perspective of the demands of private-sector industries, we find that in many areas machines were introduced, and went on to develop, in parallel with developments in the domestic machine industry.

In the areas of large steamships, railways, and cotton spinning, which were translated industries advanced by large-scale businesses, much of the machinery was imported, and the rapid introduction of electric machines led to the importing of large numbers of different kinds of machinery. That, depending on the area, it was more economically rational to adopt the transplanted industry pattern, or that even in other areas it was more rational to use imported machines, was taken for granted in Japan, where industrialization came years after the industrialization in the advanced countries of the West and where, till 1911, there was no right to impose the country’s own tariffs—a fact that itself was a contributing factor to Japan’s industrialization. Still, in the commercial structure then prevailing, it was not possible to import these machines in greater quantities unless the industries that developed through use of domestically produced machines expanded their export capacities, and for this reason, the role played by the domestic machine industry in the development of Japan’s industries as a whole was an important one. Seeing things in this light, we can say that the machine industry of that age fully responded to the needs of all Japan’s domestic industries.

We also cannot deny that the shipbuilding industry and the railway rolling stock manufacturing industry, both of which received state protection, had a steady source of demand in the country’s domestic marine transport and railway industries, and they grew by responding to that demand. The development of the machine industry in the Meiji period also, in my opinion, ought to be given credit for being what it was: a response not only to military objectives but also to a private-sector demand. On the other hand, I think that the influence exerted on the machine industry by the sudden temporary rise in demand for military supplies at the end of the Tokugawa period
and at the time of the Russo-Japanese War was greater than people have thought up till now.

The machine industry that met the demand in the traditional industries very often took the form of a regional machine industry in which machines were produced locally or in a nearby region. In these cases the machine industry waned whenever the industries that gave rise to the demand for machines waned, but its activities, though barely noticeable to the generation that followed, formed the foundation for the development of the machine industry in the next generation by the way it formed a more developed market for machines. Parts-interchangeability production in Japan made its debut after the Russo-Japanese War on just such a foundation, with the production of power looms, internal combustion engines, and machine tools.

On the other hand, it is also undeniable that large factories whose origins went back to state-owned factories that had been bought at bargain prices and under favorable terms from the government, as well as a type of enterprise—best represented by Mitsubishi and Mitsui (Shibaura Factory)—that had a division within its organization or within a keiretsu company where there was a demand for machines, and that was able to achieve domestic production of new machines thanks to its ability to pool abundant financial resources, were the main props of an important portion of Japan's machine industry. This machine industry, from the above types of large businesses right down to the medium and small factories, went on to develop in a multitiered, simultaneous progression. And within each type—sometimes extending beyond the borders of types—there was almost constant competition among individual enterprises, and this competition provided the motive power that generated that development.