ANOTHER PATH TO INDUSTRIALISATION:

The Rattling Spindle, Garabō, in the Development of the Japanese Spinning Industry

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Introductory Remarks

The typical British view of the Japanese cotton industry derives from its striking international growth during the interwar period. Extremely efficient production, price competitiveness, and aggressive marketing became the key image of the fearsome Japanese counterpart.¹ The unstoppable rise of the interwar Japanese cotton industry in the 1930s

¹ Political and Economic Planning (PEP), Report on the British Cotton Industry, London 1934; Committee On Industry and Trade (1928), Survey of Textile Industries: Cotton, Wool, Artificial Silk, Being Part III of a Survey of Industries, London; Economic Advisory Council (1930), Committee on the Cotton Industry Report Cmd.3615, (London, July); There are two governmental institutions that paid considerable attention to the Japanese cotton industry; the Board of Trade and the Foreign Office. The materials such as, BT 55/5 C.C.R.1 and C.C.R.2. CIVIL RESEARCH: Sub-Committee on Cotton Industry; Memorandum on Cotton Industry in Japan, with Copies of various Reports, Dispatches, etc. and FO 262/1843/103 British Embassy, Tokyo 1933, LABOUR JAPAN; FO 371/17153 REPORT on a Conversation between the British Consul in Osaka and Tsuda, the President of the Kanegafuchi Spinning, Concern on 24 March 1933; FO 371/17156 POLITICAL, FAR EASTERN, JAPAN; Files 583, pp.5955-6873 (1933); FO 371/17157 MEMORANDUM ON JAPANESE COMPETITION. Also, Pearse, A., The Cotton Industry of Japan and China, (the International Federation of Master Cotton Spinners’ and Manufacturers’ Associations, Manchester 1929). Also see: Ellinger, B. and H. Ellinger, ‘Japanese Competition in the Cotton Trade’, Journal of the Royal Statistical Society, (1930), Vol.XCIII, Part II.
continued in parallel with the rapid decline of the British industry in the international market and most of British attention was paid to this specific period of pain. However, no interest was shown in the genesis and the context of the much earlier developing period of the fearsome competitor. The British reports and reviews merely focused upon the interwar situation and virtually depicted the Japanese industry as coming out of the blue. In western academia, it was an American scholar\(^2\) who began to analyse specifically how the unique technological foundation of the industry was formed because of considerable British technical influences in the late 19\(^{th}\) century.

Technological choice and transfer became a major driving force that enabled the Japanese industry to develop a scheme of mass production rapidly\(^3\). It is noteworthy that the issue of the ‘supply and control of cheap labour’ received much more committed attention from the British side.\(^4\) The significance of the efficient control of economic labour was also well prioritised by the Meiji mill managers themselves.\(^5\) But, it should not be overlooked that the Japanese cotton sector was established not only by the efficient importation but also by the long-term reliance upon British spinning technology. As with the typical perspective on advantageous labour cost in late industrialisation, this feature of international technology

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\(^5\) The best example can be found in: *Dai Nippon Menshi Bōseki Dōgyō Rengōkai Hensan, Bōseki Shokkō Jijyō Chōsa Gaiyō Hōkokusho* (The All Japan Association of Cotton Spinners, A Report of Outlining The Investigation on The Situations of Labourers at Cotton Mills, published by the association in the 31\(^{st}\) Meiji Year, 1898), especially see the table of ‘recruiting regions’ in pp.2-5, and the (cultural) study of female labourers’ different personalities and preferences according to their regions (hometowns), pp.9-12, reprinted by Taiundō Shoten, Tokyo Japan, June 1971.
transfer\(^6\) is also inevitably involved with Gerschenkron’s theory of backwardness\(^7\) and Rostow’s view of ‘the take-off’ of latecomers\(^8\).

My discussion begins by casting a wary eye on both Gerschenkron’s and Rostow’s theories. The ‘prerequisite’ for them was their robust belief in the universal superiority of materialistic western technologies in any forms of industrialisation, and in the virtually one-way traffic from west to east. The two academics’ frameworks completely neglected national ethos, and religious and ideological influences within successful industrialisation. Thanks to the materialistic simplification and the elegance of their generalisations, their theories produce fluent explanations of the swiftly soaring quantitative productivity after the installation of western machinery, after the emergence of large-scale factories (with western machinery), and after the rise of new labourers (in western suits) and management (with a western education). Their greater backwardness helped the latecomers of industrialisation to take greater advantage of the state-of-the-art technologies from the West. At last, the age of high mass consumption\(^9\) has arrived like a messiah and this proves that the industrialisation was successfully accomplished. Did all of these really occur in a straight line in the Meiji cotton industry?

**The Introduction of the Garabō**

Concerning the process of Japanese industrialisation, the native sources of traditional


\(^7\) Gerschenkron, *Economic Backwardness*, Chapter One and Two.


manufacturing techniques have received relatively little attention from western scholars. This inattention was derived from a few perspectives. Firstly, although there were some general studies of pre-industrial and domestic technologies still surviving (and even continuing to grow further) throughout the process of western-style industrialisation, these have not been introduced to non-Japanese readers. The release of the Garabō to the public took place nearly a decade after the first British-style cotton mill was erected by the Satsuma. The historical context of this local technology shows that it was more than a backward local technology from pre-modern eras.

This unique indigenous technology was discussed as a mere transitional case between pre-modern primitive cotton-spinning and British-style spinning. In their views, the ‘inferior’ local technology represented no more than a brief and technically underdeveloped period before an industrial mainstream was constructed. Indeed, the Garabō technology itself could never have excelled any of the imported British textile machinery, due to its mechanically less sophisticated structure, spinning mechanism, and materials. Then, what was so significant about it?

The Third Breakthrough in Spinning Mechanism

The Jenny and the Water Frame were the initial (and only) frames, which allowed the technical leap from the primitive to the mechanised. They were invented in the 1760s in Britain and turned out to be the two symbolic breakthroughs in textile spinning. Then, there

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was the third breakthrough. More remarkably, it surfaced at the opposite end of Eurasia, i.e. Japan, more than a century later. It was the Garabō Frame, which was conceptualised throughout the first half of the 1870s, developed during the second half of the same decade and which proliferated in the 1880s. The name of the Garabō in Japanese means ‘Rattling Spindle’ (making a rattling noise of ‘Gara Gara...’ during its operation). This historically significant invention influenced the Japanese industrial revolution at the end of the 19th century, just as the brainchildren of Hargreaves and Arkwright did for the British a century previously. The spinning mechanism of the Garabō was different from those of the British frames and the structure was completely original. It was not a tool but a machine with decent concepts and mechanisms behind its operation and it produced outputs in a systematic way; its most original technical feature was the spinning mechanism that integrated the pre-spinning procedures such as opening, carding, and roving into the main spinning.14 By comparison with the technical sophistications of the Mules or the Rings, the Garabō was still plain and closer to a hand-spinning wheel. Regarding the context of its invention, the Garabō should be compared to the Jenny and the Water Frame. Despite the time gap of a century between the two British inventions and the Japanese one, their technical breakthrough in the mechanisation of spinning was equally significant. The mechanical simplicity of the Garabō induced an explosive diffusion; and it facilitated the unique process of bottom-up industrialisation. The Garabō was the only textile machine, which facilitated a considerable part of the Japanese industrialisation with exceptionally no western technical endowments.

The Delivery of the Native Spinning Frame

The first conceptual model of the native machine was made in 1873 and the first prototype

14 Yahashi, H., Garabō Montōshuu (Sono Ichi) (Gifu Prefecture Laboratory of Metallurgy 1947), p.1
was developed in 1876 after three years of tests and developments. The initial public release was made in the summer of 1877, at the First National Exhibition for Promoting Industries in Ueno, Tokyo. Despite the continuous changes for better performance, lasting until the end of the Second World War, the basic mechanism was not altered and the core structure remained. The single inventor’s engineering genius was everything in terms of the revolutionary technical departure from the primitive spinning method without any help from western endowments.

What brought about the birth of the Garabō frame? Firstly, the local demand for cotton products had been soaring since the middle of the 19th century and the traditional measure of cotton spinning could not keep up the pace. This induced an escalating need for better productivity in yarn manufacture and technical innovations in spinning became very necessary. Also, Tokimune Gaun’s pure passion for invention was the other motive. The two perspectives, the market pressure and Gaun’s dedicated invention, were interrelated and looking at their connexions should be a key to understanding the birth of the machine.

Illustration 1 Garabō, the first prototype, in the First National Exhibition for Promoting Industries in 1877

Socio-Economic Demand and Soaring Market Pressure

The seclusion policy of Tokugawa Japan throughout the 17th, 18th, and the first half of the 19th century resulted in three distinct consequences. Firstly, Japan witnessed the rise of the role-based society with its four different classes of samurai, peasant, artisan, and merchant. The upshot was social stability, maintained for over two centuries, and it encouraged more innovations in agriculture that resulted in a continuous growth in agricultural production. As Tokugawa Japan’s economic backbone was agriculture, the advance meant the growth of the national economy. Then, the second consequence was steadily increasing national wealth and, more importantly, a diffusion across the four classes. The state policy of encouraging cross-regional specialisations in manufacture and trade developed a variety of new local economic systems, networking every corner of the closed nation. Furthermore, the enduring fixed tax regime for land and agricultural production allowed peasants to have more breathing space in life and to get involved with a large variety of local economies through by-employment. Not only the scale but also the scope of the economy expanded and more economic incentives were created for people.

The third consequence was the continuing enrichment of public clothing. This derived from a simple logic: once the food supply was settled, people began to pay attention to their clothing. The Tokugawa government enforced a policy of promoting frugality and this called for several outcomes; cotton instead of silk (and of hemp for peasants) became more popular owing to its plain appearance and comfort and cotton had become more affordable for everyone. Finishing techniques such as dyeing became more advanced and this induced more innovations in weaving sectors and further sophistication in public

Table 1 The structure of the main importations in the 1860s

<table>
<thead>
<tr>
<th>Year</th>
<th>Cotton Cloth %</th>
<th>Woollen Cloth %</th>
<th>Cotton Yarn %</th>
<th>Ships %</th>
<th>Iron and Steel %</th>
<th>Total Price in US thousands $</th>
</tr>
</thead>
<tbody>
<tr>
<td>1860</td>
<td>52.80</td>
<td>39.51</td>
<td>-</td>
<td>-</td>
<td>1.21</td>
<td>945</td>
</tr>
<tr>
<td>1861</td>
<td>46.03</td>
<td>26.71</td>
<td>4.91</td>
<td>1.07</td>
<td>8.60</td>
<td>1,494</td>
</tr>
<tr>
<td>1862</td>
<td>19.36</td>
<td>17.85</td>
<td>4.18</td>
<td>16.18</td>
<td>38.74</td>
<td>3,074</td>
</tr>
<tr>
<td>1863</td>
<td>15.86</td>
<td>28.28</td>
<td>-</td>
<td>12.33</td>
<td>21.52</td>
<td>3,701</td>
</tr>
<tr>
<td>1864</td>
<td>30.87</td>
<td>29.20</td>
<td>13.61</td>
<td>1.98</td>
<td>9.55</td>
<td>5,553</td>
</tr>
<tr>
<td>1865</td>
<td>37.79</td>
<td>43.78</td>
<td>6.55</td>
<td>1.82</td>
<td>3.07</td>
<td>13,153</td>
</tr>
<tr>
<td>1866</td>
<td>No Record</td>
<td>No Record</td>
<td>No Record</td>
<td>No Record</td>
<td>No Record</td>
<td>No Record</td>
</tr>
<tr>
<td>1867</td>
<td>25.30</td>
<td>22.42</td>
<td>9.00</td>
<td>2.68</td>
<td>0.90</td>
<td>14,908</td>
</tr>
</tbody>
</table>


The Tokugawa fashion of the mid-19th century gained a massive stimulus for further growth and diversification once the importation of (exotic) foreign cloths and yarns commenced and the public desire for more varieties in texture and colour increased. The foreign cotton (52.80%) and wool (39.51%) cloth covered more than 92 percent of the gross national import of 1860. Until the end of the 1860s, the combined percentage of the textile goods (including yarns) kept its high ratio of between 80 and 60 percent. A chain reaction occurred: the sophistication of the finishing and marketing sectors pressed the weavers hard to provide more efficient cloth manufacture; and, for more production of cloth, the weaving sector began to seek more yarns. The spinning sector was still dependent upon primitive spinning wheels for yarn manufacture and it was inevitable for the spinning to be left far behind the pace of weaving. More importantly, there was no distinct division between the spinning and the weaving process: the two procedures were mostly operated by by-employed peasants and their families.

21 Andō, Y. (1975), Kindai Nippon Keizaishi Yōran, (Tokyo University Press 1975), see p.37, the Price Structure of Major Imports and Exports in the 1860s, (based upon the historical record of History of Yokohama City).

Yamawaki, T, Kinu To Momen No Edo Jidai, (Yoshikawa Kōbunkan 2002), see the Cotton Section, Part two, and Part one for imported cotton goods.

22 Kajinishi, M. (1950), Nippon Kindai Mengyō No Seiritsu, (Kadokawa Shoten 1950), Part I Pre-Industrial Period, Chapter 2 on The Development of The Early-Modern Cotton Manufacture, especially, Section 2 on The Development of Commercial Production, pp.34-9 and Section 3 on The
The relentlessly soaring importation of British and Indian cotton goods proved not only the high market demand for cloth but also the backwardness of the spinning sector. Throughout the 1870s, nearly 40 percent of the total value of the national gross import was covered by the cotton goods\(^{23}\), and the traditional system could not deliver any countermeasure to follow up local demand and to stop the flood of foreign goods. But the last hope for the traditional system was found in the dying procedure. The finishing sector realised the chemical mismatch between local dyestuffs and foreign yarns\(^{24}\). This fortunate (for spinners and weavers) and unfortunate (for finishers) condition saved the local yarn and cloth production. Another help came from a cultural factor, i.e. the distinct local tastes for textures. These cultural preferences could not be changed easily in a short period. The system of hand-spun yarn production could make use of them not only to survive but also to make some progress in locally specialised niches. The last resort for the hand-spun sector soon came to be nowhere but an extremely limited market for specialised goods.\(^{25}\)

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Imported Fabrics</th>
<th>Imported Yarn</th>
<th>Garabō</th>
<th>Domestic Machine-Spun Yarn</th>
<th>Index of Total Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>1874</td>
<td>40.3</td>
<td>26.9</td>
<td>31.1 hand-spun only</td>
<td>1.7</td>
<td>100.0 (100)</td>
</tr>
<tr>
<td>1880</td>
<td>23.4</td>
<td>40.5</td>
<td>34.9</td>
<td>1.2</td>
<td>100.0 (181)</td>
</tr>
<tr>
<td>1883</td>
<td>18.9</td>
<td>49.1</td>
<td>25.6</td>
<td>6.4</td>
<td>100.0 (128)</td>
</tr>
<tr>
<td>1888</td>
<td>15.0</td>
<td>49.7</td>
<td>25.8</td>
<td>9.5</td>
<td>100.0 (245)</td>
</tr>
<tr>
<td>1891</td>
<td>11.4</td>
<td>18.6</td>
<td>10.3</td>
<td>50.7</td>
<td>100.0 (239)</td>
</tr>
<tr>
<td>1897</td>
<td>12.3</td>
<td>10.4</td>
<td>9.8</td>
<td>67.5</td>
<td>100.0 (397)</td>
</tr>
</tbody>
</table>


\(^{24}\) Inoue, K. (1895), *Mengyō Ron*, chapter five, section three on the development of dyestuff.

Table 3 The production of cotton yarns in the Aichi prefecture (1885-1891)

<table>
<thead>
<tr>
<th>Year</th>
<th>WESTERN SECTOR</th>
<th>GARABō SECTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Production (lbs)</td>
<td>Production (Yen)</td>
</tr>
<tr>
<td>1885</td>
<td>190,900</td>
<td>39,500</td>
</tr>
<tr>
<td>1886</td>
<td>293,007</td>
<td>61,411</td>
</tr>
<tr>
<td>1887</td>
<td>451,894</td>
<td>104,300</td>
</tr>
<tr>
<td>1888</td>
<td>No Record</td>
<td>No Record</td>
</tr>
<tr>
<td>1889</td>
<td>1,954,957</td>
<td>369,175</td>
</tr>
<tr>
<td>1890</td>
<td>4,343,191</td>
<td>825,341</td>
</tr>
<tr>
<td>1891</td>
<td>3,963,914</td>
<td>691,999</td>
</tr>
</tbody>
</table>

Source: Aichi Ken Tōkeisho Menshi Seisan (1885-1891)\textsuperscript{26}; Also see Ishikawa, K. Gaun Tokimune – the invention of Garabō, p.184, table 4 for more detailed investigation. N.B. The measure for weight in the original records was ‘kan’.

\textsuperscript{1} KAN = approximately, 3.75 kilogrammes. = approximately, 8.278 pounds

The arrival of the Garabō spinning frame took place during the upheaval of the early Meiji textile market in the 1870s, and in the first half of the 1880s, a triangular competition amongst the British (and Indian) yarns, the traditional hand-spun yarns, and the Garabō yarns emerged. The most legitimate approach to understand the impact of the Garabō technology is to see the evolving composition for the supply of cotton fabrics for the domestic market. The Aichi prefecture, including the regions of Mikawa, Owari, and Chita, was the most prominent area of the Garabō-based cotton manufacture. The above statistical summary also provides a comparative review of the respective growths of the Western sector and the Garabō sector.

\textsuperscript{26} YDM 45743 Aichi Ken Tōkeisho (The Statistical Records of The Aichi Prefecture, the section on Cotton Yarn Production, from the 13th Meiji Year, 1880, to the 43rd Meiji Year, 1910), The National Diet Library of Japan, Tokyo, Japan, the sections from the 18th Meiji year to the 24th Meiji year.
The Father of the *Garabō* Frame, Tokimune Gaun.

Gaun was born on 15th August 1842. His hometown was the region of Shinano (the present-day Nagano prefecture), nicknamed the Alps of Japan. His home environment was a small basin, surrounded by tall and steep mountains. Gaun’s grandfather, Jyushirō Yokoyama, was a well-known rich farmer (and landowner) of the town and his family made a good fortune not only by means of agriculture but also by means of hosiery manufacture through local by-employment systems. This family business provided the adolescent Gaun with plentiful experiences in raw cotton growing and picking, traditional hand-spinning procedures, and assisting local cotton-spinning practices. Just like the British cotton manufacturing before the inventions of the Jenny, the Water Frame and the Mule, carding and spinning works were done by females, whereas weaving procedures were mostly handled by males, because the technically more sophisticated handlooms demanded both skill and brawn. The traditional spinning wheel (which was almost identical to the British cottage wheel) performed differently according to spinners’ skills and experiences. However, there was a positive correlation between productivity and input of hand labour. His biography tells us that Gaun’s key motive in inventing a spinning machine was to save the local people’s hands and to rescue them from their hardships due to ridiculously time-consuming traditional spinning works. Besides, the unique mechanism of spinning, which made possible not only the spindle spinning in the style of the Jenny but also continuous drawing, was originally inspired by his teenage experiences of playing with raw cotton and bamboo cylinders.

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Gaun got an education at a local Buddhist temple for a decade in his 20s (1861-1871). During this decade as a Buddhist monk, he was separated from normal life. The world had changed considerably, including the Meiji Restoration, when Gaun came back to the town. The flood of western (British) products could easily be witnessed in many areas. A nationalistic outlook might have been another motive for his invention. Even though no records give any hint of a xenophobic attitude, there is an interesting episode regarding his confidence in local endowments. In the presentation of the prototype of his Garabō frame at the First National Exhibition of Promoting Industries (held in 1777), a western attendant pointed out the laxness of the wooden gears of the machine and suggested that he adopted western metal gears. Gaun turned down this proposal and replied that he would keep improving the frame with his own methods and the available home resources. His

Illustration 2 Tokimune Gaun (1842-1900)
Source: Sakakibara, K., Gaun Tokimune, (1949).

stubbornness (or single-mindedness) was well presented in the story.\textsuperscript{32} Nevertheless, more remarkably, his obsession with creating a new spinning machine drove him to become a monk engineer. Until his death in 1900, Gaun never stopped working upon the further development of his brainchild and the constant improvement of its productivity. Gaun also had a tragic life, since he never got any personal benefit from his invention throughout his entire life. He was frequently saved from starvation by private and friendly donations (and by his extremely frugal lifestyle).\textsuperscript{33}

The Distinctive Technical Features

The key technical revolution in the arrivals of the Jenny (1767), the Water Frame (1769) and the Garabō (1876) was their replacement of human hands (fingers) by a drafting procedure in spinning. With the primitive spinning wheel, the spinners usually had to use their left hand to draft yarns (and the distance between the left hand and the right was called, the ‘drafting zone’). Purely instinctive skills and learning-by-doing experiences such as timing and delicate control of strength were everything in the procedure.\textsuperscript{34} Until the appearance of the three frames, spinning had always been a form of entirely manual work.

At this stage in the development of the art, spinning was still a rather tedious business. With the spindle of the cottage wheel rotating at a high speed, the spinster first drew out and twisted as long a length of yarn as she could conveniently manage – about 4ft

\textsuperscript{32} Miyashita, \textit{Gaun Tatchi}, p.105.

\textsuperscript{33} His miserable life in Tokyo reached the worst situation in the period before he made another presentation of an upgraded version of the spinning frames in the Second National Exhibition of Promoting Industries in 1881. \textit{Meiji Jyunen Dai Nikai Naikoku Kangyō Hakurankai Hōkokusho, Naikoku Kangyō Hakurankai Jimukyoku}, The Section Four (1881), The Secretariat of The National Exhibition of Promoting Industries, pp.54-6 (The National Archives, Tokyo, Japan; in the section of NAIKAKU BUNKO WASHO No. 3284-1). Also see, Nakamura, T. \textit{Garabō Shiwa}, pp. 90-91, Sakakibara, \textit{Gaun Tokimune}, Chapter One, Section Four on the Second National Exhibition and Gaun’s difficult life of invention, pp.17-20.

for the simple spindle and whole and perhaps 5 or 6 ft for the great wheel.\textsuperscript{35}

Both the Jenny and the Water Frame soon converged into the Crompton’s Mule in 1779\textsuperscript{36}, but the Garabô could not find a similar course of further evolution. One may distinguish two reasons. Firstly, it was not yet as sophisticated as the self-acting mule after 1830, but the spinning system of the Garabô was a technically ‘closed’ and a procedurally inseparable mechanism in its practice. The unique feature of the Garabô is the direct spinning from raw cotton (stuffed in bamboo cylinders). Gravity (i.e. the weight of the cylinders) was the power source of the drafting and the revolving of the cylinders was the method of twisting. Due to the simultaneity of these two ‘primitive’ and ‘extremely simple’ methods, there was actually no potential for technical improvements of the two moves, unless they were divided into two independent procedures. Rather than being ‘completed’, this ‘too primitive and closed’ mechanism became a cul-de-sac of further development. Hence, this did not generate subsequent conduits of newly upgraded mechanisms through integrations and alterations of the original. All the consequent innovations of the Garabô after the invention were concentrated either upon the power supply system or the mere increase (and rearrangement) of the spindles. Even though the latter got involved with increasing complexity in frame structure, the core mechanism of spinning was not altered.

The Jenny was a spindle-based spinning machine (i.e. spindle drafting), and this was technically close to the traditional cottage wheel.\textsuperscript{37} Besides, the Water Frame had its origin in the invention of roller drafting by John Wyatt and Lewis Paul, in 1738, and this machine created a new category of flyer spinning.\textsuperscript{38} These two were combined to create the spinning mechanism of the Mule. Furthermore, the Water Frame grew to be the theoretical base of the Throstle, which also subsequently led to the Ring spindles in America.\textsuperscript{39} Continuous technical evolutions were powered by means of a variety of ‘open-end’ spinning

\textsuperscript{38} \textit{Ibid.} pp.19-23.
mechanisms.

**Illustration 3 Ring Frame for spinning weft. built by Samuel Brooks of Manchester in the 1880s**


The second reason was the western sector’s rapid acclimatisation to British-style spinning. The rising British-style mills took the distinct advantage of fully relying upon the advanced British technologies rather than distracting their attention to consider the Garabō scheme. Furthermore, this reliance had already begun from the second half of the 1860s whereas the Garabō commenced from approximately 1880. It was an issue of timing: the blessed Jenny and the Water Frame were developed in the same period and in the growing industrial core of the first industrial nation. They were the first breakthroughs in the world, whereas the invention of the Garabō was as far behind as the industrialisation of Japan. The solitariness of the two British technologies implied their distinctive advance and their incomparable competitive superiority, whereas that of the Garabō merely indicated its technical isolation. The Garabō had to face the full impact of the technically superior Western sources from the beginning. For the newly emerging local technologies, such as the Garabō, the state-of-the-art British technologies were nothing but a massive obstacle. A critical drawback of Gerschenkron’s analytical framework of backwardness remains evident: firstly, his theory makes the assumption that the latecomers had ‘blank’ technological foundations thus, the
absolute superiority of the British sources was taken for granted and their dominance in the latecomers’ industrial sectors were strikingly immediate; secondly, only a few institutional settings such as state interferences, banks, and specific industrial organisations, such as cartels took the leading role of buffering the direct shock of abrupt technology transfer and of rendering smooth domestication; therefore, lastly, there was no new appearance of local technologies, because the magnitude of the British inputs were too considerable. Gerschenkron’s focus was single-mindedly placed upon the technical impact of the advanced technologies (from Britain) upon backward economies. There were no discussions of any reactions of either Italian or Russian native-source-based technologies in his debates.

Due to the massive technical gap between the British inputs and the local sources of traditions, substantial time and effort were demanded during the phase of adoption of the British-style Meiji cotton-spinning sector: more than two decades were required merely to settle down with the exotic machinery from Britain. But both the domestic market pressure and the serious concerns about overflowing foreign products did not provide the new cotton spinners with enough time.\(^40\) The development and diffusion of the Garabō within Japan was actually a countermeasure. Through the exploitation of local endowments including Gaun’s technical endeavour, a new native technology could partly fulfil the local demand and provide some breathing space for the British-style sector to bear with the technical disparity and culture shock from the first industrial nation. The Garabō was not a transitional spinning technology that bridged the gap between the traditional schemes and British-style spinning, as has been argued by a few historians.\(^41\) It was an independent and spontaneously developed technology to cope with local needs in spinning.


A Garabō frame was entirely made of local wood. From the main chassis to the gears, steers, levers and power transmissions and shafts, all the parts were made of wood pieces. This implies two features: the cost of production was far cheaper than any metal-based frames and the production was easier by handling wooden pieces rather than iron or steel parts; however, the wooden structure could not tolerate too much mechanical and physical pressure and this resulted in operational limitations in spinning speed and frame size.

![Illustration 4 A revived Garabō](image)

*Source: Miyashita, K., Gaun Tatchi, (1993).*

The spinning mechanism was the most original element: whilst the British spinning technologies entailed a complex array of pre-spinning procedures for well-prepared slivers for the stage of main spinning, the Garabō could skip all the preparatory phases: it spun

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42 The first official record, depicting the technical details of the machine can be found in the material code, 606-3312-56 Wa 3312 Gô, The National Archives, Tokyo Japan; Meiji Jyuunen Naikoku Kangyô Hakurankai Shuppin Kaisetsu (Commentaries on Exhibits at The 10th Meiji Year (1877) Exhibition of Promoting Industries). The Area 4, Machinery; The Category 3, Textile Cotton Spinning Frame, pp. 61-64; Gaun, T. from Namita-Mura, Chikuma-Gun, Shinano-Koku, Nagano-Ken
cotton yarn directly from raw cotton. This unique character had a few consequences. First of all, the quality of the yarn was inevitably coarse because of the lack of pre-spinning drafts; and the ultra-tight but uneven twist in drafting resulted in a lack of strength. Very low-count rough yarns with a hirsute towel-like texture were produced; hence no quality of fineness and sheen like British goods could be seen at all. But this distinctive texture was, in fact, the key element of local preference. The weavers and the final users did not appreciate the fineness of British yarns, because of technical mismatches in the general handling, dying as well as cultural preferences in texture. Only a few top-notch quality weavers in Nishijin, Ashikaga, Kiryuu, could appreciate the fineness of British yarns; also, they became the pioneers of actively importing British dyestuffs to develop more varieties of colours. Garabō yarns could not be used for warp due to their general strength problem and this led to a practical combination in the weaving of imported British yarn for a strong warp and of Garabō yarn for a soft weft.

In the drawing procedure, the spinning mechanism was more or less identical to that of the Jenny (of spindle drafting; intermittent spinning), but the operation was continuous; thus, it also had the character of the Water Frame (flyer drafting; continuous spinning). However, whilst all the British mechanisms were rotating spindles to draw yarn, that of the Garabō had a completely reversed mechanism: by revolving its cylinders, which were densely stuffed with raw cotton, and by utilising gravity for the drafting of yarns and adjusting both spinning speed and twist level, yarn was drawn and spun simultaneously. The wooden chassis and operating parts were the cause of the limit in spinning speed, but this unique mechanism of spinning, derived from its original speed adjusting system, prevented the frame from over-acceleration in operation. Tamagawa argued that this self-adjusting system was actually the most original and the unique engineering core of Gaun’s brainchild.

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43 *Meiji Jyuunen Naikoku Kangyō Hakurankai Shuppin Kaisetsu*, pp.62-3. Also the following provides more technical descriptions: Yahashi, H., *Garabō Montōshuu (Sono Ichi)*, (Gifu Prefecture Laboratory of Metallurgy 1947), p.1
but at the same time, he pointed out that it became the starting point of its stagnancy in further mechanical evolution. From the technical view of modern and scientific textile engineering, the Garabō spinning concept was oversimplified and, because the method of its original development was heavily dependent upon Gaun’s individual instinct and manual skills, further mechanical precision in its standardised spinning theory could not be developed. It was unfortunate that, in its earlier phase of development, the isolated native invention could not face any source of science and modern textile engineering. In the cases of the British textile machinery, including the mules and the throstles, continuous improvements of its structures and spinning mechanisms could be achieved not only by shop floor practices and records but also by scientific engineering theories throughout the 19th century. Moreover, the transatlantic diffusion of spinning technologies facilitated further mechanical sophistication as well. During the 1880s, neither any scientific theory nor any practice of the Garabō spinning was made. The production and maintenance were dependent upon every individual spinner’s handicraft and carpentering skills. Throughout the Second World War and the second half of the 1940s, its nationwide resurgence took place, and still none of the fundamental drawing and spinning mechanism could be changed from Gaun’s original prototype.

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47 Jeremy, D.J., Transatlantic Industrial Revolution, Chapter Four on The Diffusion of New Cotton Spinning Technology, 1780-1812.
Illustration 5 Garabō in the 1930s and 1940s

However, the spinning concept of the Garabō was revived in the 1960s when one of the latest spinning technologies of OE (Open End) spinning was invented.48 A century after its birth, Gaun’s art could be resurrected in a different form.

The Vicissitude of the Indigenous Technology

A Popular Machine for Everybody

The distinct cost advantage of the Garabō was the key success factor. The price of a set of the machine was so cheap that a local farmer could afford it with his average monthly income; but, more importantly, once it was studied by village carpenters, a replica could be built with ease. Besides, the lack of legal protection of the invention via patent systems49 also led the anonymous public to copy, alter, and diffuse the original frame. The consequent alterations were thus spontaneously continued by the local adopters according to their domestic requirements.

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49 The first Japanese patent system was established in 1885.
Illustration 6 The key entrepreneurs of the Garabō industry: Shigeheiji Nomura (Right Above), Rokusaburō Suzuki (Left Above), Takisaburō Kōmura (Centre), Nobugorō Ōhno (Right Below), and Genshiro Nakata (Left Below). Source: Sakakibara, K., Gaun Tokimune.

The best examples were made by Takisaburō Kōmura and Shigeheiji Nomura. Kōmura was the most active adopter, who made Gaun’s (conceptual) prototype more efficient and manageable for local spinning. Nomura was also committed to developing Gaun’s model for the sake of better productivity, especially for the mills, which were powered by water turbines. Also, a remarkable application of the original frame was made for the’ Garabō of the Plain’ by Rokusaburō Suzuki.50 For instance, the number of spindles could easily be adjusted according to the power source, either a waterfall in mountainous areas or river streams. The cost of the operation and maintenance also became another factor in its popularity. The wood-based frame allowed easy repairs and alterations. The operation did not require anything new: both brawn and traditional water wheels could be used to power the frame and there was no additional pre-spinning stage except for the primitive carding of raw cotton.

For the domestic cotton manufacturers, the most exotic and difficult features of the

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50 Aichi Ken Shi (History (and Official Records) of Aichi Prefecture), published in 1915, in the section on industry; cotton spinning. Also, see Nakamura, T., Garabō Shiwa, pp.105, 113-117, 118-121.
British-style cotton spinning were usually concentrated on the multiple pre-spinning procedures. Before they could deal with the mechanical sophistications of the mules, the developing British-style mills had to manage the inexperienced arrays of pre-spinning techniques such as slubbing and roving. The mule itself was a technically burdensome and expensive piece of machinery and the operation of the British-style spinning demanded more pieces of machines for the pre-spinning stages. This resulted in incomplete purchases of British spinning machinery. The common feature was either a technical imbalance or a lack of machines for intermediary spinning; and this was due not only to a lack of knowledge about the British-style pre-spinning procedure but also to additional costs. Furthermore, once the mills attempted to install steam engines for their power supply, another assortment of skills and technical knowledge was required for their operation and maintenance.

Last but not least, another enormous barrier for local spinners was their extremely limited access to the British textile machine makers; it was still too alien and expensive. The adoption of the Garabō therefore became the most rational measure not only of increasing productivity instantly but also of minimising the inevitable technical and financial costs of installation and operation.

The cost was a key matter, but before calculating the costs of adopting the new system of manufacture, no producer would merely attempt to increase his production without any market demand and practical benefits. One may distinguish two more perspectives. Firstly, the manufacture of yarn was inevitably influenced by any changes in the weaving sector, since yarn was an intermediate product. Abe’s study of the specialised weaving clusters proved the significant link between the indivisible growth patterns between the two sectors. The question is why the weaving sector pressurised the spinning sector for better

53 The Tamashima mill was one of the early mills, which experienced this: Kinugawa, Honpo Menshi Bōsekishi, Volume Two, Chapter Seven, especially, pp.174-85, 207-10.
productivity during the period around the Meiji Restoration. The answer is twofold: as the further specialisation and sophistication of the local weavers developed, the weaving sector only had to focus upon more weaving techniques and innovations. This led to the gradual separation of weaving from spinning. Traditionally, the two stages in cotton manufacture had involved only one procedure, because the production was mostly carried out in households, i.e. peasants spun cotton yarns and wove cloths together. The growth of the separate weaving sector thus brought about the initiative of changing the traditional procedure of cotton production.

The blurring of boundaries between the different occupations of the pre-Meiji period derived not only from the primitive methods of cotton manufacture but also from the unique structure of the Tokugawa household-based economy. Saitō’s study of the occupational patterns in Yamanashi Prefecture in 1879 presented the deep-rooted local peasant’s tradition of having multiple jobs across different sectors: traditional rice farming, handcraft works, and sales were carried out simultaneously. Despite the superficial categorisations of different manufactures, peasants, who were the majority of the local population, were involved in several occupations. Saitō argued that this distinctive socio-economic structure caused a considerable difficulty in examining the exact occupational arrangements of local economies not only of the Tokugawa period but also of the early phase of the Meiji era.

The separation of the weaving and the spinning procedures in the Meiji period thus implies a considerable change in the local system of textile manufactures, since it was directly concerned with the sudden and severe jolt to the socio-economic heritage of the Tokugawa period. Once independent weaving clusters emerged, the traditional system of cotton manufacture began to crumble and as the weaving techniques became more

(O.U.P.), pp.461-94.


sophisticated and efficient; more pressure was generated on the still household-based spinning industry. Also, the nation-wide demand for cotton cloths soared during the 1860s and the 1870s\textsuperscript{58}, and the development therefore resulted in, quantitatively, a greater demands for yarns. The limitation of the cost-based view comes from its partial analysis of the production side only; this can be overcome by looking at the market trend, shaped by the early Meiji revolution in fashion. Consumption mattered in technological development. Even though there was no direct connexion between the rattling spindles and the new vagues in clothing, the socio-economic impact of the new nation-wide trends resulted in at least a vast increase in the demand for cotton textiles in general. In fact, only the relatively high counts of cotton yarn (of over 20s i.e. 30s – 40s in Japan) were used for trend-setting quality cloths of fashion and the cotton yarn of the high counts were mostly the imported British goods.\textsuperscript{59} Until the importation of the British yarns began, the Japanese weavers had hardly experienced any cotton yarn above count 20s.\textsuperscript{60} The adoption of the British fine yarn caused an increase of variety in applications of the ‘new material’ for more novel and fashionable textile products, and the high-end fashion kept increasing the sophistication of the public perception of clothing and generating greater demand for new cloths. This implies that the inflow of the British yarns provided the local manufacturers with a positive impetus for more innovations.

Tamura argued that the most significant textile goods were a variety of woollen cloths with exotic textures and colours and the considerable popularity of the British products in the 1860s and the 1870s encouraged the domestic weavers to develop new ranges of offerings to compete with the appealing foreign goods.\textsuperscript{61} A variety of combinations of silk, cotton and woollen yarns attempted to produce more competitive goods and the British cotton yarn played an important role in the innovation by being interwoven with local silk or cotton yarns. Tamura pointed out a new perspective on the British yarn, flowing into the

\textsuperscript{58} Nakamura, S., *Meiji Ishin No Kiso Kōzō* (Miraisha 1968), especially Chapter Five presents the noticeable increase of the import volume of cotton goods as well as the faster growth in demand, compared to domestic production.

\textsuperscript{59} Tamura, *Fashion No Shakai Keizaishi*. Especially, see Chapter Two on ‘the innovations in the traditional weaving sector and the British cotton yarn’.

\textsuperscript{60} Even the British-style Meiji mills could not produce any counts above 20’s until the beginning of the 1890s.

\textsuperscript{61} Tamura, *Fashion No Shakai Keizaishi*, Chapter One, Section Two on the development of fashion market and the British textile goods. pp. 36-47.
Meiji market in the 1870s; the active importation and application of the British cotton yarns was to compete with the popular British woollen cloths.\(^6^2\) New demands for both traditional coarse cotton yarn (with relatively lower counts) and a range of medium counts emerged continuously along with the weavers’ competitive strategies; however, with the technical capacity of the 1870s, the Meiji spinning sector had to commit itself, firstly, to developing a system of mass production of coarse yarns.\(^6^3\) Two means were developed: the Meiji government promoted the British-style mills but certain technical difficulties required a considerable time lag and time-consuming learning curves; the other measure was developed by the public and it turned out to be the Garabō-based scheme. Whilst the former was developed together with a variety of governmental publications and technical journals, the latter did not require much information because there was no official knowledge shared by Garabō spinners.

There were two channels for sharing technical knowledge and hastening the process of pan-industrial learning of British textile technologies. The first was the governmental journals such as Kōmukyoku Geppō (The Bureau of Engineering Monthly from 1882) and Nōshōkō Kōhō (The Gazette of Agriculture, Commerce, and Engineering, published by The Ministry of Agriculture, Commerce, and Engineering, from March 1885).\(^6^4\) The other was mostly published by the Association of Cotton Spinners including Rengō Bōseki Geppō (The Association of Cotton Spinners Monthly, printed from May 1889).\(^6^5\) The Garabō system had to rely upon each individual spinner’s technical and managerial

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\(^6^2\) Ibid. Section Three, pp.48-60.

\(^6^3\) Kinugawa, *Honpō Menshi Bōsekishi*, Volume One, Two, and Three for the earlier mills and their vicissitudes.


competence rather than upon a scientific method of theorising their techniques and practices. Whereas the British-style sector attempted to establish ‘scientific standards’ in spinning and management practices, the Garabō sector had to be operated by means of ‘individual and local art’. The two different paths were developed throughout the second half of the 1870s and the whole of the 1880s. This identical timing tells us that the two were driven by the same demand and change in the textile market, although they were dependent upon different sources of technological development. The former adopted the British method and the latter simply stuck to its indigenous sources.

The initiative of the British-style spinning was inevitably limited to only a few selected people, but the Garabō system was virtually open to anybody and the impact of the technical breakthrough on the public was immediate. The explosive diffusion of the rattling spindles amongst traditional spinners was an expected consequence, allied with the public rationale from cost-benefit analysis. After the first disclosure of the machine to the public at the First National Exhibition for Promoting Industries (at Ueno in Tokyo), within less than three years, more than 150 Garabō mills were established in Tokyo (only), 25 in Aichi Prefecture and more than two dozen Garabō managers were active in the Kansai area. The Tokyo branch office of the Renmensha, which was the official manufacturer of the Garabō spinning frame, recorded sales of 585 frames after the exhibition as well. But this recorded figure does not represent the actual level of diffusion during the 1880s. The only available statistical source to examine the impact of the Garabō technology on the domestic yarn production in the period can be seen in the changing composition of different yarn supplies to the weaving sector, but the Garabō section was subsumed into the traditional section of hand-spun yarn in the records. The most severe statistical limitation can be attributed to the spinning frame’s technical distinctiveness: the economy of easy and quick replication by the anonymous populace. Along with the familiarity of its parts, materials, and operational

66 Right after the completion and local release of the prototype, Gaun established the Renmensha with a few of his local colleagues for both the production and sale of the Garabō in May 1876. However, this company was dissolved by the end of 1880. See Ishikawa, K., Gaun Tokimune (Nippon Hyōronsya 1986), p.161 and p.167.
67 Mentō Kyōshinkai Hōkokusho (The Association of Promoting Cotton and Sugar Manufactures), at Osaka, February 1880, cited in Nakamura, T., Garabō Shiwa (Keio Shuppansha 1942), pp.83-4; Murase, Gaun Tatchi, Chapter Three, the nation-wide diffusion of the Garabō, especially, pp.62-3; Sakakibara, K., Gaun Tokimune (Okazaki City, Japan, April 1949), pp.8.
68 See the Table 2 ‘the Composition of Supply of Cotton Fabrics’.
methods, the new machine proved to be ‘another convenient agricultural tool for the usual household cotton-spinning work’ rather than an exotic technology that required new socio-economic organisations or collective technical developments. The key element of the rapid diffusion therefore consisted in its psychological familiarity. A few domestic Garabō spinning communities emerged throughout the 1880s, but none of them was involved with developing themselves into western-style factory-based schemes. This was a natural consequence, since the Garabō spinners were local merchants, spinners, and farmers, who were attached to their traditions and cultures not to the western concepts of modern industries. Neither for the state nor for the public, it is still virtually impossible to examine the actual number (or precise statistics) of the rattling spindles in operation in the 1880s.

**Purely Domestic Systems of Cotton Manufactures in the Meiji Industrialisation**

Two types of the Garabō-based domestic systems of cotton manufacture began to emerge just after the introduction of the technology to the public in 1877. The first was located in mountainous areas, taking advantage of the natural power source of waterpower from steep valleys. The other system was developed around the vicinities of fast-flowing rivers. Clusters of anchored boats with waterwheels were arrayed on the rivers and the boats were transformed into tiny spinning mills. The former was called the Garabō of the Mountain, the latter the Garabō of the Plain (or of the Boat).69 Although the two systems operated completely identical Garabō spinning frames, the different power sources led the two systems to evolve into diverse industrial organisations. More complex and sophisticated putting-out and contract systems were developed in the mountain version, whereas the plain type sought flexible production that was adaptable to changing river streams.

The manufacturers in the mountains represented a typical type of putting-out before industrialisation: a group of Garabō spinners teamed up and placed their spinning frames in a traditional mill (for grinding rice or extracting vegetable oil)70, and this set up a temporary

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70 *Wabō* (Japanese Cotton Spinning; Throstle Spinning & Weaving), The Secretariat of the Japan Association of Wabō, April 1949, p.2. Section Two, The Power Supply of Garabō Spinning.
contract between the spinners and a mill owner, who was offering the workshop and the power source. In most cases, the mill owners also placed their spinning frames beside those of the tenant spinners and they spun cotton yarns together.71 According to the size of the mills, the number of the spinners varied, but the scale could not grow out of the blue without any technological breakthrough in the power supply. Two inevitable constraints to growth followed: the key appeal of the Garabō system was its advantage of exploiting already-existing traditional measures, including local waterwheels. No mill owners were interested in the extra costs of expanding their mills and in replacing their waterwheels with new bigger turbines. The key benefit of the system became the main restraint upon its further growth. The other constraint existed in the static relationship amongst the spinners: Nakamura pointed out that they merely teamed up to collectively approach the available local mill owners and the power supply from their waterwheels.72 No institutions for more sophisticated collective contracts were spontaneously developed amongst the farmer-spinners and the mill owners.73 This shows that, in general, the Garabō spinning was taken on as another secondary job for extra income (with no additional costs) along with their usual farming work. Nonetheless, some changes occurred in regions like Mikawa (the present-time Aichi Prefecture, the east side). Initially, the cotton spinning was casual labour for a limited period, i.e. for the agricultural off-season only. The Garabō system achieved its quickest proliferation in arid and mountainous regions with a relatively poor agricultural performance. It did not take long for the cotton spinning to become the main form of work. Domestic weavers in some vicinities (such as Chita74) began to develop networks with the Garabō spinners, and this evolving system of putting out revealed the sole specialisation of the cotton spinning i.e. the separation of spinning and weaving, and the breakdown of the traditional type of household cotton manufacture.

71 Murase, Gaun Tatchi, p.128.
72 Mikawa Suisha Bösekigyō Nı Kansuru Chōsa Siryō (A Collection of Research Materials on the Mikawa Waterwheel Cotton Spinning, 1919, published by the Provisional Bureau of Industrial Survey; the survey had been done in 1917).
74 Chita Momen (Chita Grey Cotton) was one of the most well-known traditional brands of cotton cloth and other cotton goods since the Tokugawa era. The region of Chita is located on present-day Owari Ichinomiya in the Aichi Prefecture.
The theory of proto-industrialisation\textsuperscript{75} might be recalled from this developing pattern, but two perspectives remain distinctive in their difference: firstly, the Garabō-based manufacture was born a decade later than the birth of the British-style Meiji cotton mills. The time-consuming (and learning-by-doing) phase of acclimatising to the British system did not allow the western sector to deal efficiently with the market demand. The linear context of development in the theory of proto-industrialisation was reversed and mixed up in this case. The most significant perspective is that the native-source-based response through the rise of the new domestic system of manufacture was commenced after the western impact. It had developed its own technical capacity for launching new putting-out systems and even factory-like institutions in a remarkably short period. The Gerschenkronian ‘backwardness’ was witnessed only in the western sectors. Secondly, although the Garabō system grew into form a variety of integrated organisations, it is not clear whether they can be precisely defined as a ‘factory-based’ system in western terms. For instance, the Nukata-Böseki-gumi (The Nukata Association of Cotton Spinning) was one of the largest Garabō-spinning complexes and it achieved remarkable productivity and cost efficiency throughout the 1880s. This association was established in 1884 by water-wheel-based cotton spinners in the Mikawa regions and, at the beginning, the number of members (i.e. cotton masters) in Nukata County was 264 and the number of total spindles was recorded as 44,320. The average number of spindles per spinner was thus 168 and this indicates that each spinner ran 2-4 Garabō frames. Thus, the spinners were running very small and basic units. The total yarn production per year of the association recorded 62,317 kan (=approximately 233.6 tons, 1 kan = 3.75 kg); this indicates that the average yarn production per spinner reached approximately 885 kg. The annual production of the traditional hand-spinning managed to manufacture, on average, 62 kg per spinner; this tells us that the Nukata spinners with the Garabō frames could increase their productivity by at least 14 times, compared to the

traditional measure. Although it was a mere association of individual and independent small-scale spinners, the striking increase of the productivity signifies the impact of the Garabō technology on the local cotton manufacture.

Table 4 The production of the Nukata Cotton Spinning Association

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Members</th>
<th>Number of Spinners</th>
<th>Number of Spindles</th>
<th>Production (Weight: Pound)</th>
<th>Production (Value: Yen)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1884</td>
<td>264</td>
<td>242</td>
<td>44,320</td>
<td>517,231</td>
<td>-</td>
</tr>
<tr>
<td>1885</td>
<td>316</td>
<td>405</td>
<td>60,080</td>
<td>742,369</td>
<td>142,408</td>
</tr>
<tr>
<td>1886</td>
<td>452</td>
<td>580</td>
<td>98,760</td>
<td>1,789,679</td>
<td>187,064</td>
</tr>
<tr>
<td>1887</td>
<td>483</td>
<td>615</td>
<td>131,530</td>
<td>2,561,687</td>
<td>492,850</td>
</tr>
<tr>
<td>1888</td>
<td>481</td>
<td>612</td>
<td>112,290</td>
<td>2,376,572</td>
<td>455,800</td>
</tr>
<tr>
<td>1889</td>
<td>376</td>
<td>508</td>
<td>107,281</td>
<td>2,243,822</td>
<td>433,364</td>
</tr>
<tr>
<td>1890</td>
<td>208</td>
<td>203</td>
<td>70,172</td>
<td>1,681,995</td>
<td>298,585</td>
</tr>
<tr>
<td>1891</td>
<td>196</td>
<td>161</td>
<td>67,025</td>
<td>883,411</td>
<td>104,360</td>
</tr>
<tr>
<td>1892</td>
<td>206</td>
<td>241</td>
<td>74,618</td>
<td>1,548,199</td>
<td>237,050</td>
</tr>
<tr>
<td>1893</td>
<td>239</td>
<td>378</td>
<td>103,871</td>
<td>2,484,522</td>
<td>346,618</td>
</tr>
</tbody>
</table>

Source: Mikawa Bōsekai Dōgyō Kumiai Hen, Mikawa Bōseekishi, cited in Ishikawa, K., Gaun Tokimune – the Invention of Garabō, The Table Three in p.176. N.B. The measure for weight in the original records was ‘kan’. 1 KAN = approx. 3.75 kilograms. = approx. 8.3 pounds

However, no Garabō mills transformed themselves into steam-powered factories; instead, after their sudden knockout from the main stage of domestic spinning in 1890, petrol engines and electric power were adopted during its restoration much later in the 1930s. Besides, the association members did not arrange any western-style management systems with official employer-employee contracts. The leading figures like Takisaburō Kōmura coordinated the spinning works, but the individual spinners were running their business independently. Remarkably, a ‘factory-like’ system was witnessed much later, during the Second World War, under the Showa war regime with the controlled economy. For instance, within the Aichi prefecture only, there were nearly 1.3 million Garabō spindles in operation in 1940; and, by

76 Nakamura, Garabō Shiwa, pp.104-5, his comparative study of the traditional hand-spinning and the Garabō production; the average productivity of Garabō was approximately 13-14 times more productive, quoted: Meiji Jyuuyonen Dai Nikai Naikoku Kangyō Hakurankai Hōkokusho, Naikoku Kangyō Hakurankai Jimukyoku, (1877), Tokyo 1877, The section on the Garabō in Matsumoto, Shinshuu (the present-day Nagano Prefecture), pp.54-6; also Kōmukyoku Geppō, Vol.11. on yarn production.

77 Nakamura, T., Garabō Shiwa. pp114-16; Sakakibara, Gaun Tokimune, pp.28-9; Miyashita, Gaun Tatchi, p.122.

78 Sakakibara, Gaun Tokimune, Chapter 3 and 4, pp.26-31, 32-35.
1945, the number of prefectures, who were running the rattling spindles increased from 5 to 23. The zenith was achieved just after the war in 1947; the total number of spindles reached 3.3 million and 32 prefectures (out of 43) were in operation.\textsuperscript{79} The native technology of labour saving (as well as resource-saving) came back on to the main stage of spinning for the war economy. The Garabō scheme steadily developed its own surviving path, and either according to local calls or to nation-wide necessity, it came back and was placed in operation.

The Garabō of the Plain developed a different vicissitude from that of the mountain version. The first system of yarn manufacture was launched by Rokusaburō Suzuki in the autumn of 1878, and was followed by the locals within a year. The founder of the plain version, Suzuki, put great effort into fully absorbing the mechanism of the Garabō frame and he made a visit to Gaun to receive his direct tutorials. Until his retreat from the Yahagi-Hurukawa (which was a tributary of Yahagi main river) due to the big flood in August 1882, Suzuki’s system was a leading model for the Garabō of the Plain, and the number of mills on Yahagi River reached a hundred in 1897.\textsuperscript{80} The plain system was less affected by any competition with the British-style mills, whereas the Garabō of the Mountain was severely (and immediately) hit by the rise of the western sector already in 1889-90. The plain system dealt with rather limited local demands only, and there is no record that any well-organised putting-out structure was developed. The Garabō frames with approximately a hundred spindles were installed on each boat and, except for the main spinning procedure, all the other phases of cotton manufacture were operated at the riverside. Thus, rather than being a fixed large factory, clusters of huts for pre-spinning preparations on the riverside and of boats for the main spinning emerged like tiny mobile villages.


\textsuperscript{80} Sakakibara, Gaun Tokimune, Chapter 3, Section 3, pp.29-30.
A spinner, who was also the owner of his boat\textsuperscript{81}, played the role of a spinner as well as of a ‘captain’. The size of boats varied, but the usual boat reached a length of 10 ‘ma’ (since 1 ma = approx. 1.818 metre = approx. 6 feet, hence, 18.18 metres = approx. 60 feet) and a width of 1’ma’. He controlled the boat; then, the manufactured Garabō yarns were prepared for sales on the riverside (by his family). After 1885, bigger boats appeared and, in 1904, the average size increased to a length of 13 ma (=approx. 23.6 metres = approx. 78 feet) and a width of 3 ma (=approx. 5.45 metres = 18 feet). This created a remarkable scenery in which a party of boats with wheels and ceilings were grouped together and were ferried by small boats carrying carded raw cotton in (from the riverside) and manufactured yarns out (to the riverside). Neither fumes nor steam could be seen from this assembly of ‘mills’ on the river. But, the rattling sounds from the waterwheels beside the ‘boat mills’ meant that their spinning works were well in progress. The power supply from the stream could not generate as much torque as the waterwheels of the mountain system hence, till 1885, a waterwheel could power 30-90 spindles only. However, from the turn of the century, a series of continuous technical improvements in both the performance of the waterwheel and the

\textsuperscript{81} Murase, M. Gaun Tatchi, p.87, also Nakamura, T. Garabō Shiwa, p.120.
power transmission enabled a boat to operate 240 spindles in 1904 and soon 300-320 spindles were in operation as well.\textsuperscript{82} The bands of clattering boats also raised their anchors from time to time and slowly shifted their locations together in accordance with changes of the river stream. This indicates that the key concern in the plain system as in the mountain system, was the power supply.

The end of the Garabō of the Plain came with the replacement of its power source from the river stream to petrol engines and electric motors in the 20\textsuperscript{th} century. The spinners were at last ‘disembarked’, and the Garabō mills began to be built in urban areas or any regions that were close to their demand sides, i.e. the local weavers of Garabō yarns. The densest spot of the boat spinning was in the lower reaches of the Yahagi River, the region of Hazu. In this specific location in 1898, 59 Garabō boats in operation were witnessed. The end of the Garabō of the Plain came in 1933, and this was due not only to the spinners’ adoption of petrol engines and electric motors for their power supply, but also to the domestic government’s project of repairing the riverside region.\textsuperscript{83} This unique vicissitude of another Garabō system reminds us of the unmatched significance of their power supply for any mechanisations. It was not only the British-style mills of the 1880s but also the Garabō mills of the early 20\textsuperscript{th} century that experienced the consequence of changing their power source: the revolutionary departure from waterpower enabled the two sectors to relocate themselves to more strategic regions that were closer to weavers and raw cotton suppliers.

\textbf{The Garabō in the Local Textile Dynamics}

The Garabō-based system complied more efficiently with local market demands than the developing British-style mills, at least during the 1880s. Technically, it was impossible for the wooden Garabō to achieve the level of productivity that was achieved by the British spinning machinery of the 1880s. The Nukata Association of Garabō Spinning recorded an average of 19.6 kilogrammes of yarn production per spindle in a year and this resulted in

\textsuperscript{82} Murase, Gaun Tatchi, p.88.

\textsuperscript{83} Wabō (Japanese Cotton Spinning; Throstle Spinning & Weaving), p.2. Section Two, The Power Supply of Garabō Spinning.
approximately 53.7 grammes per spindle in a day. The average production of the western sector (with both the Mule and the Ring) in 1889 reached approximately 326.3 grammes (by Rings) and of approximately 240 grammes (by Mules); the former was six times more productive and the latter four and a half times more productive than the Garabō production. Regarding the counts, the average of the Garabō was 16.2s in 1885, whereas that of the western sector was recorded as still 14s in 1890. In considering the time lag (1885 and 1890) as well as the counts (16.2s and 14s), the British frames could be roughly three to four times more productive than the Garabō spindles. But, the Garabō spun the yarns that were welcomed and preferred by a majority of the local weavers of the time. This was natural since the native culture, including individual domestic tastes and preferences in textile quality, could not be changed in a short period; for instance, the steady popularity of the Garabō yarns amongst local weavers of traditional hosieries was not challenged until the interwar period.

What was the most significant implication of the Garabō technology? The first was a considerable improvement of productivity. The basic unit of a spinning frame with 100 spindles achieved an increase of up to 13 times in yarn production, compared to the average output from the traditional hand-spinning method. A skilful spinner could operate the basic unit and the noticeable increase of productivity indicates that the Garabō spinning frame was a technological breakthrough for labour-saving effort. Whilst labour-saving technologies in western terms such as the mules and steam engines entailed an inevitable resource-intensiveness, the Garabō technology did not, because of the ‘strikingly cheap’ cost of manufacture and operation. The ‘resources’ are not only the financial capital or mineral

84 Nakamura, T., Garabō Shiwa, pp114-16; Sakakibara, Gaun Tokimune, pp.28-9; Miyashita, Gaun Tatchi, p.122 for the data of the production of the Nukata Spinning Association; regarding the data of the western sector’s performance, see Nippon Menshi Bōsekigō Enkaku Kiji, published by Nōshōmushō, the Ministry of Agriculture and Commerce (in 1901), Chapter Five Cotton Yarn, especially see the table in p.101. Concerning the data of the Garabō counts, see: Nōmukyoku Kōmukyoku Zanshi Orimono Tōshikkai Kyōshinkai Shinsa Hōkokusho (The Assessment Report by Bureau of Agricultural Affairs; Bureau of Engineering Affairs. The Association of Promoting Silk Yarn and Cloth, Pottery and Japanese Lacquer), Yurindō, 1885, pp.1-189.

85 This was an upgraded version for Garabō ‘factories’ (spinning mills). The original version was equipped with 40 spindles. Miiji Jinya Naiikoku Kangyō Hakurankai Shuppin Kaisetsu, The Section Four 1877, pp.61-4.

86 With the traditional hand-spinning wheel, a female spinner could produce 40-50 momme of cotton yarn (1momme = 3.75 grammes, i.e. 150 grammes – 187.5 grammes) per day; whereas a Garabō spinner manufactured, on average, 650 momme (=approx. 2,438 grammes = approx. 2.4 kg).
resources but also the scientific knowledge and application needed to build and run the machines. The most important feature of the native technology was the labour-saving effect but, more remarkably, it also began to develop resource-saving potentials by consuming wasted cotton and low quality raw cotton (from the British-style mills) after 1890. Raw cotton wastes could be easily collected from the workshop floor of the British-style mills and Garabō frames could spin coarse yarns for mostly traditional hosiery and rough cotton cloths for miscellaneous purposes.87

The parting of the ‘muddled’ procedures of the traditional cotton manufactures was a revolutionary development in the Meiji cotton production. Especially, the rise of the independent spinning sector was the most consequential transformation. Both the western-style spinning mills and the Garabō technology facilitated the structural change, but their methods were dissimilar: the former produced a complete technical discontinuity through the importing of the alien technologies and manufacturing formats, whereas the latter developed technical continuity by fully exploiting native endowments. The delivery of the Garabō technology and its impact upon the rise of the native mills in parallel with the developing British-style sector presented a new perspective: the Meiji industrialisation was more than the mere adoption and transfer of ‘the western technologies and schemes’ to carry out ‘productivity growth in the western style’. Just as the Meiji bureaucrats were aware of the desperate necessity of mass manufacture, the public were also highly responsive to the technical demands of the period. The rise of the Garabō spinning system was an embodiment of the public rationale of complying with the evolving dynamics of local textile markets.

New Evolution after the Inescapable Dropout

A few elements caused the sudden death of the Garabō technology after 1890. Firstly, the decline of domestic cotton farming became noticeable after the importation of cheaper foreign (mostly Chinese) raw cotton soared; the cotton agriculture was no longer a profitable business for peasants. The Garabō spinners also began to use the imported raw cotton and

87 Nakamura, T., Garabō Shiwa. p.165.
this was an abandonment of the usual local advantage of closely linking the raw cotton supply and the spinning phase. Secondly, after 1885, and during the following five years, the British-style spinning sector developed a pan-industrial technological transformation and this led not only to the significant increase of production but also to the rapid fall of prices. The western sector’s main production was concentrated upon either similar or even lower (e.g. 14s) counts to those of Garabō products (i.e. average 16s), and its price competitiveness undermined the usual advantage of Garabō yarns both in terms of price and of taste. Furthermore, the number of the western mills showed a dramatic increase in the same period and, together with the technological impact of the newly adopted British rings on their better productivity in low counts, the consequence was a striking upsurge in production. In the first half of 1885, the number of total spindles in operation was 47,220; and the total production was recorded as 235,110 kan (= approx. 881 tons). 5 years later, in 1890, the former increased to 253,466 spindles (more than 5 times), and the latter was recorded as 5,201,969 kan (=approx. 19,507.3 tons, an increase by 22 times). Another 5 years later in 1895, the former went further up to 541,042 spindles (more than 11 times from the 1885’s) and the latter soared to 18,411,106 kan (=approx. 69,042 tons, an increase by more than 78 times from the 1885’s). In 1899, the annual production reached 37,709,378 Kan (=approx. 141,410 tons, an increase by 161 times) from the total spindles of 1,056,858. The production of the British Ring-spun yarn already surpassed that of the Mules even before 1890; and before 1900, the Mules’ production went constantly down to nearly one percent of the Rings’, and this tells us that, throughout the 1890s, the Ring became completely dominant.

The distinctive technical continuity led to two consequences: the public adoption was much more efficient, but the mere compound of native sources could not provide an effective measure to deal with the fall of the traditional agricultures and the by-employment systems. Whilst the Pacific war went on, the Garabō technology returned to the main stage of cotton manufacture. Its unique origin appealed politically to the war state. Garabō

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88 Nippon Menshi Bōsekigyō Enkaku Kiji, (1901), Chapter Five Cotton Yarn, especially see the table in p.101.
89 Nippon Menshi Bōsekigyō Enkaku Kiji, Chapter Five Cotton Yarn, especially see the table in p.101.
90 Sakakibara, Gaun Tokimune, chapter 7 on the industrial transition during war time and chapter 8 on the state control of the Garabō sector (under the war regime).
The distinctive vicissitudes of the Garabō provide a few important theoretical implications. The most essential source of its noticeable popularity as well as its rapid diffusion was its cost efficiency, derived from its great technical compatibility with the traditional system of cotton manufacture. It is certain that the native technology enabled the local peasants to maintain their conventional scheme of by-employment in company with a conspicuous increase in productivity. The vigorous rise of the Garabō sector presents a rare Japanese case of completely evolutionary industrial development in every aspect, including the attention-grabbing technological breakthrough. Nonetheless, the early rising phase was truncated by its strikingly sudden death after 1889 and its flourishing period did not last more than a decade. It is worth noting that the timing of its abrupt demise was virtually identical with the beginning phase of the British-style spinning sector’s takeoff. The technical limits and underdeveloped features of the spinning mechanism have already been argued but, more importantly, the Garabō sector could not meet the development of a modern scheme of management. As was described in the case of the Nukata spinning association, there was no further evolution in management and the Garabō technology was merely adopted as another

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technical source to improve the general productivity of the unaffected traditional system of cotton manufacture. Thus, the Garabō technology as a groundbreaking industrial innovation could not be accompanied by a compatible level of managerial transformation, whilst the British-style sector was facing an avant-garde phase of managerial innovation, viz. the birth and rise of modern entrepreneurship. Regardless of its technological immaturity, and despite the inevitable departure of the Garabō from the main stage of the Meiji cotton manufacture, it still remained there. This view is underpinned by its remarkable return and its further technological advance in the much later interwar period and by its invaluable contribution to the contemporary concept of spinning technology.

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