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Translation notes

1. The translator's original English translations are given in round brackets.
2. The words enclosed by square brackets are not part of the original text but added into the translation in order to make the text coherent and comprehensible.
3. The English words in single quotation marks are literal translations of the original Japanese words.

Introduction

Edo Period Karakuri Culture and Japanese Robots

A Book Published in Three Major Cities.

Karakuri Zui — Karakuri Diagram Collection — is a unique and remarkable book. Original in its objectives, it offers extraordinarily detailed information about the automatic mechanical devices known as *karakuri* which were manufactured in Japan during the Edo period (1603-1867). Within its three volumes unfold a treasury of wonderful works: three kinds of mechanical clocks and nine kinds of *zashiki karakuri* (mechanical toys for indoor entertainment), each of them accompanied by diagrams that precisely depict the process of their manufacture. Thanks to the survival of this book, readers today are able not only to understand the mechanical devices of the Edo period but can even attempt to reconstruct them. The value of the work lies not only in its presentation of intriguing devices; it is also an important historical document for the study of Japanese technology and for situating *karakuri* within the history of world automata.

Karakuri Zui was published three times: in Edo (present day Tokyo) and Osaka in 1796, and in Kyoto in 1808.¹ Edo was the base of the Tokugawa shogunate, while Osaka was the center of the nation's commerce, and Kyoto the capital and home of the emperor. That *Karakuri Zui* was published in these three important centers is alone a clear indication of its popularity at the time. The author's name was Hosokawa Hanzō Yorinao (c.1749-96), though he is more commonly known as Hosokawa Hanzō. His name was a combination of "Hosokawa", his family name, "Hanzō", his childhood moniker, and "Yorinao", his given name. In East Asia the given name follows the family name and in this text all Japanese and Chinese names are written in accord with this convention.



Karakuri Zui.

1. Suzuki Kazuyoshi, *Karakuri Ningyo*, (Tokyo, Gakushukenkyusha, 1994), 96.

The Author : An Astronomer with a Talent for Making Mechanical Devices.

While much is unclear about the life of Hosokawa Hanzō,² it is known that he was born on Shikoku Island as the eldest son of a family of country samurai, and brought up there, in Nishinoji village of Nagaoka province in the Tosa region.³ As a youth he studied Confucianism under Tobe Yoshihiro (1713-95) who was a well-known scholar of Tosa, and learned astronomy from Kataoka Naojirō (1705-69).

In around 1778, Hosokawa departed for his studies in Kyoto. It is known that while he was there he made two *shaten-gi* devices which were used for cosmic mapping. Apparently he presented one of these to his feudal lord and the other to the family of Sakakibara Dainagon,⁴ Kyoto-based nobility. He also created a gadget that could tell time and determine direction without the use of a magnet, and a kind of pedometer called a *kōtei-gi* (distance measure). Another of his constructions during this period was a *mannen dokei* (eternal clock)⁵ with a cock on top of it that displayed the time. He is known, also, to have repaired a clock that had been made by a *karakuri* maker of Tosa. Yet despite such productive output, his only known surviving works are a clock and a tea-serving doll.

Hosokawa set out for the then capital, Edo, in 1791. Upon departure he inscribed a vow on a pillar of the bridge at the entrance to his village and left behind him the bold proclamation: "If I cannot become famous and make a name for myself in the world, I shall not cross this bridge again". Once in Edo, Hosokawa became pupil of Yamaji Saisuke (1761-1810), was a scholar and staff member of the Shogunal astronomical observatory. It is possible that the young Hosokawa encountered Morishima Chūryo (1754-1810) during that period. Morishima was the younger brother of Katsuragawa Hoshū (1751-1809), the doctor who served the shogun. Morishima himself was a doctor, a Dutch Studies enthusiast,⁶ an author of light fiction and a composer of comic *tanka* poetry. Whenever members of the Japanese branch of the Dutch East India Company visited Edo for an audience with the shogun, Katsuragawa made a point of meeting with them in order to attain news from outside world.⁷ Morishima, it seems, managed to meet many Dutchmen through Katsuragawa and like Katsuragawa he too became knowledgeable about the West. Katsuragawa's home was a well-known salon for intellectuals of the time, and Hosokawa may well have been one of the participants. Quite possibly he was influenced by Morishima, for the latter was also the author of the introduction to *Karakuri Zui*.

In 1794, Hosokawa was appointed calendar-making assistant in the Shogunal astronomical observatory and he was involved in the project of revising the current calendar — the *Hōryaku reki*⁸ — since it was replete with errors. The project was completed in 1797 and a new calendar — the *Kansei reki*⁹ — was produced. However, Hosokawa passed away one year before the completion of the project. The nature of his involvement in the reworking of the calendar is unclear. And while one theory holds that he died as a result of illness, and another

that he was poisoned, the cause of his death, too, is unknown.

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2. Suzuki Kazuyoshi, *Karakuri Ningyō*, 90-93. Information about his life is provided by two main documents. One is *Bunkai Zakki* by the Confucian scholar Yuasa Jōzan (1708-81). The other is the 1844 *Tosa Kijin Den*, a collection of biographies of "eccentric characters" of Tosa.
 3. Hosokawa's birthplace was the present Nankoku city in Kōchi prefecture.
 4. *Dainagon* is a title denoting a specific government rank.
 5. *Mannen* literally means "ten thousand years" and is a word used to signify eternity. *Dokei* is the euphonic alternation of *tokei* which means both clock and watch in Japanese, but as most Edo period *tokei* were clocks, *tokei* and *dokei* are both translated here as "clock" for convenience.
 6. Dutch Studies flourished in Japan from around the mid-eighteenth century. See the section "Scientifically minded Citizens fascinated by *Karakuri Zui*", on page 31.
 7. See the note 46 regarding the Tokugawa shogunate's foreign policy.
 8. This calendar was in use from the fifth year of the Hōryaku era (1755) and was accordingly called *Hōryaku reki* (Hōryaku calendar). Incidentally, era name changes accompanied changes in ruler, or reflected an auspicious event or an unhappy one, and they were frequently implemented during the Edo period. The Hōryaku era lasted from 1751 to 1763.
 9. This calendar was in use from the tenth year of the Kansei era (1798), and thus was named *Kansei reki* (Kansei calendar). The Kansei era lasted from 1789 to 1800. Concerning this revision project, see page 32.

China : The Father of Karakuri.

While the word "automata" is often used to translate it, the Japanese word "karakuri" does not mean "automatic." Rather, it indicates the mechanism, the mechanical device, and occasionally the trick itself. The origin of this word is unknown but it is thought to have derived from a combination of the verbs *karamu* (to twine) and *kuru* (to reel). More certain is our knowledge of the origin of this device-making: much technology and culture related to the field of karakuri seems to have been imported from very early times to Japan from China.

A Chinese priest, who became a naturalized Japanese citizen, is said to have constructed an ingenious device called the "South Pointing Chariot" in 658, which he presented to the imperial court in the year 666.¹⁰ The South Pointing Chariot was a figure standing on a chariot with its arm outstretched and pointing in a direction that remained fixed regardless of the movement of the chariot. The direction of the figure was fixed to face south, which was in accordance with the Chinese notion of that time that the emperor ought to face south in order to govern. The base upon which the figure was poised was connected to the two wheels fixed on each side of the vehicle and fitted with a kind of differential gear system. The gears were controlled by operation of a long handle attached to the horses. A legend relates that this device was invented during the era of the Yellow Emperor (27 B.C), but the earliest seems to have been made around the middle of 3rd century by the Chinese scholar and engineer Ma Jun (ca. 200-265).

Levers, pulleys, lathes, pumps, water clocks, water wheels, puppets and other objects required to make karakuri were also imported from China to Japan, but until the sixteenth century the development of mechanical devices in Japan was a very gradual one. However, a notable karakuri of an earlier period is a water clock¹¹ that appeared

in the *Chōya Gunsai*, a compilation of official and private documents edited by the scholar Miyoshi Tameyasu (1049-1139) in 1116. This clock was displayed at around the end of the eleventh century at Enryaku-ji the Buddhist temple complex at Mount Hiei near Kyoto. It was made by the priest-astronomer Nichikaku (dates unknown) and consisted of a hemisphere and a square base. Twelve model animals indicated the time by appearing in turn on the clock; a child-like doll stood at the center of the base and pointed in order to show the time.¹² The display of time was not only visual: a sound also accompanied the doll's motion as it indicated the hour. The form of the clock may have reflected the ancient Chinese portrayal of the universe as composed of a spherical heaven and a square earth.

During the mid-fifteenth century, many *karakuri tōrō* (puppet lanterns) were made for the *Bon* Festival.¹³ These were often mentioned in the diaries of aristocrats and such accounts suggest that dolls or scenic views were worked around or inside the lanterns. It would also appear that the mechanisms were not automatic but rather were manipulated with manually operated strings. They were displayed at major temples, the residences of aristocrats, and the imperial court.¹⁴

10. *Nihon Shoki*, 720 A.D. *Nihon Shoki* is one of the oldest Japanese histories and its compilation was an imperial project.

11. According to *Nihon Shoki*, the first domestic water clock in Japan was made in 660 A.D. by Prince Naka no Ōe, the later Emperor Tenji (626-71).

12. Hashimoto Manpei, *Nihon no Jikoku Seido*, (Tokyo, Hanawashobō, 1966), 41-76, 89-91. The following is a summary of Hashimoto's explanation.

In the period when Nichikaku made this clock, the official system used was the regular timekeeping system and a day was divided into twelve *shin-koku*. *Chōya Gunsai* relates that the passing of one *koku* was marked by this clock with one motion made by the doll and that of one *shin-koku* was marked with eight motions. *Koku* and *shin-koku* were the units of time used in the period. This means that the doll would point to a total of ninety-six *koku* in one day. The time system which divided a day into ninety-six *koku* was unusual and the reason for its use is unknown.

Up until the end of the Edo period, the timekeeping system of Japan was extremely problematic. Two regular time keeping systems were in use. One was used in the *Guchū reki* calendar which was issued from the eighth century until 1868 by the ministry attached to the imperial court in charge of matters concerning calendars, astronomy and astrology. According to information given in *Guchū reki*, one *shin-koku* was the equivalent of four and one-sixth of a *koku*, meaning that twelve *shin-koku* consisted of fifty *koku*. Another timekeeping system appears in the *Engi shiki*, a collection of regulations issued by the imperial court which were first enforced in 967. Here a day was made up of twelve *shin-koku* but one *shin-koku* was divided into four *koku*, so a day was the length of forty-eight *koku*. These timekeeping systems were probably original Japanese inventions. Yet another regular timekeeping system used in Japan divided a day into one hundred *koku*. This system was imported from China. In the sixteenth century the temporal timekeeping system became widely used and as *koku* were used as a unit in this system too care must be taken when converting the *koku* into the modern hour.

13. A Buddhist ceremony held on July fifteenth according to the old lunar calendar. As departed souls are believed to return to their homes on that day, people prepare lanterns to guide the spirits on their way.

14. Suzuki Kazuyoshi, *Karakuri Ningyō*, 24.

Europe : The Mother.

Visits by Europeans to Japan in the mid-sixteenth century marked a turning point in Japanese history. Jesuit priest Francisco Xavier (1506-52) arrived in Japan in 1549 and traveled to Kyoto to attain permission from the emperor to propagate Christianity. However, the city had by that time been ruined by the wars between feudal lords struggling for supremacy.¹⁵ Xavier abandoned his plans for missionary work in Kyoto and moved to Yamaguchi, a western region of Honshu Island over which a strong feudal lord, Ōuchi Yoshitaka (1507-51), held power.

In 1551, he had an audience with Ōuchi, and was granted permission to propagate his religious teachings. Among the gifts Xavier presented to Ōuchi was a European mechanical clock. This was described in *Ōuchi Yoshitaka Ki*, a biography of Ōuchi thought to have been written either by one of his chief retainers or someone connected to them. The oldest record of this mechanical clock, it relates that, "...it marks the twelve [units of] time. It is not adjusted [according to] the changing length of day and night, and it makes a bell ring..." The gift was also mentioned in one of Xavier's letters to the Jesuits in Europe.¹⁶ At the time, most Japanese used the temporal timekeeping system for everyday life,¹⁷ and when they saw the clock given by Xavier to Ōuchi, they apparently found it hard to believe that a timekeeping device with a cycle comprised of twelve units could operate without appropriate adjustment to the differing lengths of day and night. The automatic mechanisms that indicated the time and made the bell ring no doubt amazed them too. Sadly, this clock has not survived, but since that time many mechanical clocks were brought to Japan by Europeans. The oldest surviving European clock in Japan was made in Spain in 1581, and had been presented to Tokugawa Ieyasu (1542-1616), the first shogun of the Edo period.



The oldest surviving mechanical clock in Japan. Presented to Tokugawa Ieyasu. Courtesy of Kunozan Toshogu Museum.



Model of early escapement. Work of Minesaki Sougo. This escapement consists of a crown wheel (a wheel with inclined teeth), a "verge" with two "pallets" (pegs), and a "foliot" (balance) with two adjustment weights. Two pallets are moved right and left by the crown wheel. The oscillating speed of the foliot on the top of the verge is controlled by changing the position of the adjustment weights. The crown wheel is driven by the weights connected to a rope hanging on a wheel, which has a gear and a ratchet inside it. The early European clocks used this kind of escapement system and it is thought to have been invented in the latter half of the thirteenth century.

15. The Japanese Warring States period comprised most of the sixteenth century.

16. Kōno Yoshinori, *Sei Francisco Xavier Zen-shokan vol.3* (Tokyo, Heibonsha, 1985), 181.

17. The temporal timekeeping system came to be used during the Warring States period because the ongoing warfare disrupted the functions of the imperial court and made the popularization of the regular timekeeping system impossible. The temporal timekeeping system was naturally convenient for everyday life at a time when both night lights and clocks were scarce.

Takeda Ōmi : Creator of the Karakuri Entertainment Show.



A Japanese weight driven clock indicates temporal time with the use of double balances. Late Edo period, Oumi Jingu Shrine Clock and Watch Museum. The movement of the two balances changes automatically to adjust to day or night-time. The variation of day length from one season to another is adjusted for manually by positioning the weights of each balance.

See the note 2, page 53.



A face of the Japanese clock indicates temporal time by use of *wari-koma*, which are moveable time plates, late Edo period, Oumi Jingu Shrine Clock and Watch Museum. There are grooves inside and outside the dial and the time plates are fitted between them. The plates had to be adjusted manually on the early types but later versions had automatically adjustable time plates. See the note 2 of page 53.

Tokugawa Ieyasu founded his shogunate at Edo in 1603, but he and his clan contended with the strife of the Warring States period for about thirty years after that. The battle that stabilized the ruling position of his shogunate was the Shimabara Rebellion¹⁸ which took place on Kyushu Island from 1637 to 1638. “Pax Tokugawa” was at last established in 1638 and the shogunate maintained peace for almost two hundred years.

The blossoming of karakuri culture was one of the gifts of Pax Tokugawa. The Japanese were manufacturing unique domestic clocks at around the beginning of the Edo period.¹⁹ They utilized the European clock mechanism but developed a number of ways to indicate temporal time.²⁰ Some types of these clocks are explained in *Karakuri Zui*. It appears that they were first used in the castles or houses of shoguns and feudal lords, and after the stability of the Tokugawa shogunate was established, wealthy people and city belfries were able to acquire them too.

In 1662, an epochal event in the history of karakuri occurred with the raising of the curtain of the Takeda Karakuri Theater in Osaka. This theater was the first karakuri theater. It staged the biggest shows of mechanical devices during the Edo period and continued for more than a hundred years. Its glory days were described in the famous eighteenth century tour guide book *Settsu Meisho Zue* (Illustrations of Famous Places of Settsu)²¹ which declared that “if tourists from east, west or the countryside do not see Takeda Karakuri during their stay in Osaka, their visit can be said to be worthless”.

The founder of this theater was Takeda Ōmi Kiyofusa (?-1704). According to *Settsu Meisho Zue*, he was born in Awa state²² on Shikoku Island and later moved to Edo. He regularly visited a temple where, it is said, he prayed to find work by which he himself could prosper while being able to provide for others as well. As the story goes, one day on his way home from the temple, he saw a child playing with sand. For him the sight provided divine inspiration and it was after this that he devised a sandglass.

He subsequently went to Kyoto where he made a karakuri doll which he presented to the emperor in 1658. The imperial court conferred on him the prestigious title of *Izumo no jō*. Since Izumo is an eastern region of the present Tottori prefecture, on Honshu Island and “*jō*” signifies a government post in the district, *Izumo no jō* was in fact, nominally, a title for the officer of Izumo. In the Edo period an honorary government post title was required of anyone who wished to stage a theater show, but it was the superior craftsmanship of Takeda’s karakuri doll that had resulted in the bestowal of the title. In 1659 he was awarded the title of *Ōmi no jō*.²³ Perhaps the title of *Izumo no jō* had been deemed inadequate, for Ōmi is the old name of the present day Shiga prefecture and it was larger than Izumo. There were two ranks of *Ōmi no jō*: *Ōmi sho-jō* and *Ōmi dai-jō*. *Dai-jō* was the higher of the two. Takeda’s title was *Ōmi sho-jō* but it was