III. Forming Technological Foundations in Modern Japan

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From Traditional to Modern Metrology

The Introduction and Acceptance of the Metric System

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Measurement is the basis of a civilization. Uniform standard units, in turn, are the basis of measurement. Based on such standard units, government taxes people, merchants trade goods, and architects build houses. To keep its sophisticated social, economic, and technological mechanisms operating smoothly, the modern world demands ever more precise and more universal measurements.

The introduction of modern measurement to Japan came at the end of the Edo period, when the Tokugawa government started to introduce Western technologies. After the Meiji Restoration in 1868, the new Meiji government became engaged in the more radical project of modernizing every facet of Japanese society. In this project, the establishment of a metrological system was a priority. As Japanese in the Meiji period tried to assimilate the intellectual, institutional, and social systems of the Western world, they encountered two Western metrological systems: the British yard-and-pound system and the French metric system. The introduction of the metric system, which was internationally established almost simultaneously with the Meiji Restoration, naturally attracted Japanese leaders with scientific minds; today, it is the principal metrological system used in Japan. However, the transition from the native standards to the metric measures was by no means quick or smooth. The conversion to the metric system was complicated by the strong influence of British engineering on Japanese industries in the Meiji period, which ensured the prevalence of the yard-pound system in the industrial sector. Thus, three systems of weights and measures—native, British, and metric—coexisted and

rivaled one another from the beginning of the Meiji era up until World War II.

This chapter will survey the history of the transition from native to metric metrology, highlighting the following points: (1) how the new Meiji government used the new metrological system to sustain its control over local areas, and how its policies differed from those of Edo times; (2) how the standardization affected, and was affected by, the coexistence of the two Western systems; (3) how champions of the metric system promoted it; and (4) how the opponents of the metric system defended native measurements.[1]

1. The Control of Weights and Measures in the Edo Period

The system of weights and measures in Edo Japan was closely related to its social structure and the relationship among the four social classes: samurai-rulers, farmers, craftsmen, and merchants. Rice was the second currency in Edo Japan, and all samurai salaries were paid in volume (not weight) units of rice taxed from farmers.[2] Instruments to measure the volume of rice as well as the instruments for weighing were exclusively made by a special group of craftsmen. Using these measuring instruments, merchants were allowed to trade fairly freely between producers and consumers.

During this period, the Tokugawa (central) government authorized two trade guilds (*za*) to manufacture measuring instruments: *hakariza* for making balances, and *masuza* for volume measures.[3] Officers of

1. This chapter is primarily based on the following two works on the history of Japanese metrology: Mētoruhō Jikkō Iinkai, ed., *Nihon Mētoruhō Enkakushi* (*A History of the Metric System in Japan*) (Tokyo: Nihon Keiryō Kyōkai, 1967) and Nihon Keiryō Kyōkai, ed., *Keiryō Hyakunenshi* (*A Hundred-Year History of Measurement*) (Tokyo: Nihon Keiryō Kyōkai, 1978).
2. The wealth of a *han* was measured by the estimated volume of rice taxed each year.
3. *Za* had been originally meant for a designated seat (*za*) for privileged tradesmen on the occasion of religious or political festivals. Such monopoly groups, privileged families, were organized around various kinds of consumer goods—oil, gold, and so forth. For *hakariza*, see Hideo Hayashi, *Hakariza* (Tokyo: Yoshikawa Kōbunkan, 1973), and Kesakatsu Koizumi, *Hakari* (Tokyo: Hosei University Press, 1982). For *masuza,* see

the central and local governments periodically inspected balances and measures in use in towns, and confiscated all nonstandard balances and arrested their makers. A law established in 1742 stipulated that makers of deviant measures should be dragged around town and then executed.

Despite such strict laws, measurements of volume and length were less rigorous and less unified than those of weight. Although the central government authorized only two *masuza* in Edo and Kyoto to make authentic volume measures, each domain was responsible for collecting tax tributes from its farmers, and some of them designated local makers of volume-measuring vessels, with some of these vessels differing slightly from officially approved measures.

The size of a standard *masu* (wooden square vessel) was fixed by the government. In 1669 the Tokugawa government defined the unit volume *shō* as a volume of 4.9 *sun* in length and width and a depth of 2.7 *sun*. Standard volume was thus defined in terms of units of length, but the government did not rigorously control the latter. Although there were orthodox units of length and area used in carpentry and in the measurement of rice fields, modified versions of scales were widely used among the public, and the standard of length was not tightly controlled until after the Meiji Restoration.

2. The Meiji Government's Reform of the Weights and Measures System

The control of measures was an urgent task for the Meiji government, because of its pressing need to reform the tax system and replenish the treasury so badly depleted by revolutionary warfare. After the Restoration, the control of weights and measures fell under the control of the Ministry of Finance. In 1870, a Section of Metrological Reform was set up in the Ministry of Finance and charged with developing a new, adequate system of weights and measures.

The 1870s brought the establishment of the international treaty of the metric system. The idea of an international unification of

Kesakatsu Koizumi, *Masu* (Tokyo: Hosei University Press, 1980).

weights-and-measures systems through the metric system became a possibility, owing to active French promotion efforts at World Fairs and scientific discussions of discrepancies in data from geodetic surveys in the previous decade. The International Commission of the Meter was first held in 1870 in the Congress on the Metric System, and at the second meeting in 1875, the Meter Convention was signed by seventeen countries.

The head of the Reform Section, Eiich Shibusawa (1840–1931) was introduced to the metric system by the physicist, Aikitsu Tanakadate (1856–1952). Shibusawa, the would-be founder of the Japanese business world, had briefly studied economics in the West. Another member of the section was a graduate student of the Nagasaki Naval Training School who had been taught by Dutch naval officers and engineers. Perhaps because of the presence of such members with Western knowledge, the Section attempted to designate the metric system as the standard metrological system. Their first plan, proposed in 1870, was to adopt the native shaku scale, but to define its length simply as one-third of a meter. This radical proposal, however, was flatly rejected by government leaders.

The Shibusawa group had to find an independent method of defining the native unit of length. Partly because there had been no guild in the Edo period specifically responsible for manufacturing scales, various kinds of scales were widely used. Scales for tailors (*kujira jaku*)[4] and those for carpenters (*magari jaku*)[5] both employed the unit *shaku*, but their actual lengths were slightly different. The scales for carpenters required more precision and were regarded as more authentic, but even they displayed variations.

Shibusawa's group consulted Itsumi Uchida (1805–1882), an expert in traditional mathematics, on this matter. Uchida possessed three ancient and apparently authentic *shaku* unit scales. The longest and allegedly the oldest among them was selected for use as a formal

4. The *kujira jaku*, literally meaning "whale scale," was so named because it used to be made of a whalebone whose flexibility was suited for tailoring.

5. The *magari jaku* literally means a "curved (or more precisely, cornered) scale." Carpenters used such cornered scales, with a right-angle corner and two differently calibrated scales, to ease architectural calculation.

standard of length, but it soon turned out that the volume measure made by this unit differed from the volume unit then widely circulating in Japan. They thus switched to the medium-size unit scale, and on the basis of this scale, the Law of the Regulation of Weights and Measures was established in 1875.

That same year, the Convention of the Meter was signed in Europe, and the French government invited the Japanese government to join. The proposal by the Ministry of Finance to sign this international treaty, however, was defeated because of opposition from the Ministry of Home Affairs. In 1881, the management of weights and measures was transferred from the Ministry of Finance to the Ministry of Agriculture and Commerce, which proposed participation in the treaty in 1885. This time, the proposal was approved, and a Committee for the Investigation of Weights and Measures was set up under this ministry.

The Committee included three notable scientists: the meteorologist Seio Nakamura, the physicist Kenjirō Yamakawa (1854–1931), and the mathematician Dairoku Kikuchi (1859–1917) (who later became a member of the House of Peers, President of Tokyo Imperial University, and Minister of Education). The three unanimously endorsed adoption of the metric system, as they were convinced that it would become the future standard in metrology. Nakamura decided, or diplomatically negotiated, that the basis of longitude would be taken from England, while the standard for units would be taken from France.[6] The Committee's proposed plan for the Law of Weights and Measures adopted the native unit *shaku*, but defined it as 10/33 of a meter, which was considered close enough to the length of the medium-size *shaku* scale.

The Law of Weights and Measures was thus established in 1891. It passed the Diet immediately after the protocols for the meter and the kilogram arrived from France. According to this law, the basic units to be used were the traditional *shaku* and *kan*, but they were defined as 10/33 meter and 15/4 kilograms, respectively. The Japanese gov-

6. Seio Nakamura, "Kaikodan (A Recollection)," Doryōkō, no. 137 (1923), quoted in *Nihon Mētoruhō Enkakushi.*

ernment requested the International Bureau of Weights and Measures to construct *shaku* and *kan* protocols in accord with the above sizes, and the request was accepted: the *shaku* protocol was made by truncating a meter protocol, while the *kan* protocol was constructed separately.[7] Upon arrival in Japan, these made-to-order original and suboriginal protocols were preserved at the Ministry of Agriculture and Commerce, and protocols for local governments were replicated, based on the latter.

The actual enforcement of the law required a number of specialist officers as well as authentic protocols. According to this law, those who made, sold, and repaired measures were required to let their instruments be examined and to receive permission in advance to conduct their business; those who used measures for their business were to be tested every five years (the first regular testing took place in 1899). In addition, the local government occasionally tested the instruments used in shops.

To carry out this program, it was necessary to establish a testing station at each prefecture, and to supply metrology specialists to these stations. In order to meet this demand, the Ministry of Agriculture and Commerce requested the Tokyo Physics College to set up a program of metrology and to teach the basics of the subject for would-be metrological bureaucrats. The Tokyo Physics College had been established by graduates of the "French Physics Class" of Tokyo University (the short-lived predecessor of Tokyo Imperial University, which, in turn, was the predecessor of the present University of Tokyo). When the predecessor of Tokyo University had been reformed in 1873, English was chosen as the primary foreign language, and a new Department of Arts was temporarily set up as a refuge for those students who had been studying with French teachers. The Department of Arts, often referred to as the Department of French Physics, existed until 1880.[8] Graduates of the French Physics Department naturally

7. Keiryō Kenkyūjo, ed., *Keiryō Kenkyūjo Hachijūnenshi* (*An Eighty-Year History of Metrological Laboratory*) (Nihari, Ibaraki: Keiryō Kenkyūjo, 1984), unpublished, p. 42.

8. Tokyo Daigaku Hyakunenshi Henshū Iinkai, ed., *Tokyo Daigaku Hyakunenshi* (*The Centennial History of the University of Tokyo*), *Bukyokushi*, vol. 2 (Tokyo: Uniersity of Tokyo Press, 1987), p. 336.

showed strong interest in metrology and the metric system, and many of them played leading roles in introducing and promoting the metric system in Japan. Munanori Takanose, for instance, was one of the founders of the Tokyo Physics College and was in charge of metrological reform at the Ministry of Agriculture and Commerce; he served as a liaison between the College and the Ministry. The Metrological Program at the College continued from 1891 to 1893, and during this three-year span, it produced some sixty experts in metrology as the manpower for local testing stations.

3. The Spread of the Yard-Pound System and the Amendment of the Law

The French physics graduates, however, were a minority among scientists and engineers in Meiji Japan, and their aspirations for an internationally unified metric system was not shared by engineers, in particular. The introduction of Western knowledge from different countries in different disciplines caused the adoption and persistence of the two Western metrological systems. The medical and pharmaceutical fields adopted the metric system because of their almost exclusive reliance on German medicine. Science in general adopted the international system, although many American and British scientists came to teach various scientific subjects in Japan. The army, too, adopted the international metric system, because it learned of it first from the French army and then from the German. The navy, however, adopted the British system because of its close connection with the British navy, despite its earlier connection with French naval engineers through the construction of the Yokosuka Dockyard as was shown in Chapter 3.

As far as industrial technologies were concerned, however, British influence was by far the most dominant. The Ministry of Engineering, which until 1885 was in charge of every facet of technological matters, from engineering education to large construction projects, relied almost exclusively on hired British engineers. The Imperial College of Engineering (the predecessor of the Engineering School of Tokyo Imperial University), too, was dominated by young British

engineering teachers. These British engineering practitioners and educators naturally employed their native metrological system. At classrooms and construction sites, things were measured by yards and pounds, and imported materials and machines were measured and calibrated in the British way.

The 1893 law was designed primarily by prestigious scientists, and it did not reach this industrial reality of Meiji Japan. One grave consequence of the widespread use of the yard-and-pound system in Japanese industries was that their measures were not regulated by the Japanese Measurement Law. Foreigners inside some designated areas could live and work under the laws of their own country until their extraterritorial rights were lifted by the Treaty Revision of 1899. Already in 1885, a group of balance makers in Tokyo had petitioned for government regulation of balances and measures based on the British system, complaining of how rival Japanese makers made such measures without official approval. The answer from the Ministry of Agriculture and Commerce was apologetic. It stated that the compulsory enforcement of the metric system was impractical because the pound unit was then ten times more widely used than the gram in Japan; at the same time, compulsory enforcement of the British system was also unwise because the metric system would most probably prevail in future industries.

It was not just in private sectors that the enforcement of the metric system was deemed difficult. The Ministry of Posts and Telecommunications, which had inherited some national projects from the Ministry of Engineering, investigated in 1901 how difficult it would be to shift from the yard-and-pound to the metric system. The report concluded that it would not be difficult to make the switch in the inspection of ships and in telecommunications, but would be very problematic in the case of the railroads.

In 1909, the 1893 law of Weights and Measures finally was amended, and the use of the yard-and-pound for measurement was officially approved. The government now had also to test scales and measures calibrated by the yard-and-pound system. However, it limited such testing to just three stations in Tokyo, Osaka, and Fukuoka, and set their testing fees higher than normal so as to discourage the

use of yard-and-pound instruments. Nonetheless, statistics from 1911 show that more than half of the total scales tested at the three designated stations were of the yard-and-pound system.

4. World War I and Standardization

The metric system had so far been largely promoted by a group of leading scientists with a keen interest in metrology. World War I brought significant changes in perception among engineers. The all-out, consuming nature of war strained the nation's industrial power to the utmost. All came to recognize that in order to increase industrial productivity, the standardization of parts and processes was critical.

Before World War I, the military and the government had attempted to standardize some parts of processes. The army tried to standardize the size of nails as early as in 1903, and the navy standardized the method of testing materials for ship building. In 1905 the Ministry of Agriculture and Commerce set up a committee to standardize the testing of Portland cement; the committee fixed the content of its basic components, and the way to test characteristics such as the strength and the rate of expansion in concrete made out of the tested cement. In 1913, the Japanese Association of Engineering was asked by the mayor of Tokyo to standardize the sizes of iron water pipes. It formed a committee consisting of representatives of academia, local governments, and the military, and the committee reported its conclusions to the Tokyo municipal government. But enforcement of the new specifications proved difficult.[9]

After World War I, the Japanese Association of Engineering set up another committee to investigate more systematically the standardization and the improvement of both engineering education and technological development in general. The committee, comprised of representatives of a dozen engineering societies, considered that the

9. Eisuke Yoshida, "Kōgyōhin Kikaku Tōitsu Jigyō no Gaiyō (A Survey of the Project of Industrial Standardization)," *Kōgyō Chōsa Ihō* (*Reports on Industrial Investigation*), 1 (1923), quoted in *Nihon Kagaku Gijutsushi Taikei*, vol. 3 (Tokyo: Daiichi Hōki, 1967), pp. 272–276, on p. 273.

standardization of nuts, bolts, and screw nails was the most urgent and important task, and concluded that they should be standardized by the Whitworth system until an international standard for them became fixed.

The government was now engaged in the problem of standardization. In 1919 the Ministry of Agriculture and Commerce formed an Investigative Committee for Weights and Measures and the Standardization of Industrial Goods. Within the same year, it concluded that weights and measures should be unified by the metric system. By the next year it specified the kinds of materials and parts to be standardized, listing forty-seven items divided into four categories: metallic and nonmetallic materials, electrical equipment, mechanical components, and machine tools. More specifically, it selected twelve items which more urgently required standardization, including the shapes and sizes of such parts and materials as steel and iron materials, pipes, rivets, wires, wood materials, bricks, incandescent lamps, nuts and bolts, valves and cocks. It further recommended that a permanent committee be established to investigate this matter more thoroughly and to discuss procedures for the implementation of these standards. The Investigative Committee for the Standardization of Industrial Goods was thus established in 1921, with about seventy members drawn from governmental departments and engineering societies, as well as from universities and corporations. The committee had four subcommittees, corresponding to the four categories in the report of the previous committee, and they held an intensive series of discussions after the first main meeting held in October 1921. After the conclusions of the investigations were approved in the subcommittees and the main committee, the proposals were submitted to the Ministry of Agriculture and Commerce, and eventually became the Japanese Engineering Standard (JES). The work of this Investigative Committee continued after a part of the Ministry of Agriculture and Commerce was reorganized in April 1925 into the Ministry of Commerce and Industry (the predecessor of the present MITI), and from 1930 it worked under the Special Bureau of Industrial Rationalization. By 1941 it had determined some 520 JES items.

The direct purpose of the establishment of these standards was to

make parts interchangeable and improve efficiency, but it also aimed at raising the quality of industrial goods and the level of Japanese industries in general. Kiyoshi Ogawa, who wrote a prewar history of standardization, remarked in 1949 that while units should be standardized according to the metric system, the following points should be taken into account: if a product were still under development, premature standardization should be avoided so as not to hamper its rapid development; tradition should also be taken into account.[10] Reflecting the large influence of United Kingdom and United States industrial technologies, some standards for machines and their basic components were set in the British system. As an engineering professor of Tokyo Imperial University stated as late as 1926, the switch to the metric system from the yard-and-pond system at the University was considered difficult in mechanical engineering and naval architecture, though less problematic in civil engineering, architecture, and aeronautical engineering.

5. The Law of the Metric System and the Promotion of the Ideology of Measurement

Nevertheless, the conclusion of the Investigative Committee promptly led to the complete reformulation of the Law of Weights and Measures. About a year after its conclusion on the metric system was submitted, a proposal for the amendment of the law was submitted to the Congress. The proposed law selected metric units as the basis of weights and measures in general, and, in contrast to the previous law, banned the use of units other than those of the metric system. The minutes of the Diet Committee meeting where this amendment was discussed reveal that the discussion was conducted in a hurried way. A representative asked the estimated costs of changing the entire metrological system, and asked that officers in charge of this job be summoned from each ministry. The chairman, Kaichirō

10. The Japan Society of Mechanical Engineers, ed., *Nihon Kikai Kōgyō Gojūnen* (*Fifty Years of the Japanese Machine Industry*) (Tokyo: The Japan Society of Mechanical Engineers, 1949), pp. 1099–1144, on pp. 1106–7.

Imaizumi (1867–1941), declared that there had already been enough discussion in the Investigative Committee, and that such a summons was unnecessary. The law was passed and promulgated as law on 11 April 1921. The day was then commemorated as the day of weights and measures.

According to the new law, two kinds of moratorium periods were set for the public and private sectors: a ten-year moratorium was given to the public sector, and an additional ten years given to the private. All basic units had to be replaced by the metric system within these moratoria. During discussion in the Diet, Shiryō Kikkawa referred to discussions in the United States Congress, which suggested that if the United States decided to adopt the metric system, its government would need much "propaganda" to implement it because the British system was so widely used in American industry and among the American people. The Japanese government, too, was aware of the need for propaganda to promote the metric system.

The government had a good assistant in this, namely the Japanese Society of Weights and Measures. The Society's predecessor, the Great Japanese Society of Weights and Measures, had been established in 1894, a year after the original Law of Weights and Measures had been enforced; the society had disappeared, however, around the time when opinion leaned toward official approval of the yard-and-pound system. The renamed Japanese Society of Weights and Measures was established in 1911, for the purpose of promoting the metric system and *keiryō shisō*—the thought or ideology of measurement. This measurement ideology perhaps acted as a key word in the spread of the metric system in Japan. The society went far beyond propagandizing for the metric system itself; it promoted a fundamental change in the way of life—the modernization of life style.

After the new Measurement Law with the metric system passed, the Society enthusiastically promoted the metric system in every quarter of Japanese society through such means as pamphlets, exhibitions, and lectures. An exhibition on measurement was held at the Tokyo Educational Museum (the predecessor of the present National

Science Museum) two months after the promulgation of the law.[11] It aimed to promote both the metric system and the use of precise measurement to improve efficiency and equality. The Society decided to make a film for this occasion, and put out a call for scripts in its official journal, *Doryōkō* (*Weights and Measures*). The winning script, "Keitarō Nikki (Diary of a Measure Boy)," was written by a graduate of a law school, and was made into a movie by a curator of the Tokyo Educational Museum. The original script followed the hero from his childhood into his twenties, but the curator-director remade it into a film about one day in the life of nine-year-old Keitarō.

In the film, Keitarō learned at school about measurement and became fascinated with it. Returning from school, he asked his mother if she had a balance at home. She answered that they had previously had one, but the father had sold it when the house had been cleaned at the end of the previous year, because they had used it only very rarely and considered it unnecessary. Disappointed, Keitarō emphasized the importance of measurement, imitating his teacher's way of speaking, and he asked his father to buy a new balance. He and his father then went to the center of Tokyo and bought one. Back home, Keitarō immediately started to weigh everything around him, small or large, from small goods to people such as himself and the servant. Happy, Keitarō went to bed clutching his own cherished balance.

The film continues with the next day, a Sunday. Keitarō pursued his game of measuring all things at home. And he made an amazing discovery. The actual amounts of sugar, *miso* (Japanese fermented soybean paste), and beef—all differed slightly from the amounts ordered from the shops. The next day, he and his father visited the Tokyo Metrological Bureau and observed the metrological instruments and the tests conducted with them. On their way back, they purchased a set of all essential measuring devices for domestic use. The following

11. Tokyoto Keiryō Kenteijo (Tokyo Metrological Station), ed., *Tokyo no Doryōkō Gyōsei Shiwa* (*Administrative History of Metrology in Tokyo*), unpublished, p. 483. The exhibition, however, was not mentioned in the official history of the National Science Museum, *Kokuritsu Kagaku Hakubutsukan Hyakunenshi* (*The Centennial History of the National Science Museum*) (Tokyo: The National Science Museum, 1977).

day, shop servants showed up and tried to sell goods to Keitarō's family. It turned out that the liquor, the rice, the sugar, and the charcoal they had brought were actually all less than the amount they claimed to be selling, so the boys from the shops were told to leave. The only exception was the boy from a meat shop who luckily had heard about what was going on inside, and managed to devise cunning tactics on the spot. Keitarō's diary of that day opened with the words: "I was very pleased. Every boy from the shops was hard pressed [to explain the discrepancy]."[12]

This film was displayed at the exhibition in Tokyo, which successfully attracted 30,000 visitors. Even after the exhibition in 1921, the film was kept at the office of the Japanese Metrological Society and a copy was loaned out upon request.[13] Following this success, the Society went on to make other promotional films and other events.

The next year, a similar but larger exhibition—perhaps the largest in the period – was held in Osaka. The materials displayed in this Osaka exhibition were compiled and published as a book. This book contains numerous illustrations, and shows us how seriously the Japan Society of Weights and Measures, backed by the Ministry of Agriculture and Commerce, tried to promote the diffusion of the metric system, seemingly targeting the Japanese middle class. The exhibition occupied a large space, and used several buildings to display its five sections. Each section was designed to explain some aspect of the metric system, and the importance of measurement in education, at home, in society, and in industry. One of the displayed posters showed the thermal efficiency of pots of different shapes under the title "Which pot is economical?" Another showed the scene of an elderly traveler arguing about his bill with the cashier of the hotel where he had stayed, while a departing ship was visible through the window. Under the title "A penny for an Englishman," the caption explained that the ever-exact Englishman was meticulous about one penny, even if his scheduled ship was departing from the port.

The exhibition on measurement held in Tokyo was part of a series

12. *Tokyo no Doryōkō Gyōsei Shiwa*, op.cit., pp. 484–486.

13. It was unfortunately destroyed at the great earthquake in 1923. Ibid., p. 486.

of special exhibitions at the Tokyo Educational Museum, which aimed at the scientific enlightenment of the wider public. The series was organized under the leadership of Gentarō Tanahashi, a museum specialist who emphasized the importance of visual displays in science. From 1916, the Tokyo Educational Museum held exhibitions on such themes as "The Prevention of Cholera," "The Great War and Science," "Domestic Science," "Time," and "The Improvement of Domestic Life." The last exhibition, which was intended to rationalize every facet of domestic life, led to the formation of the Association for the Improvement of Domestic Life with Tanahashi at its head, which subsequently organized similar exhibitions nationwide.[14] This and later exhibitions on measurement seem to have resonated with the movement to improve domestic efficiency.

6. The Conservative Reaction to the Metric System

When the ten-year moratorium for the enforcement of the metric system came to a close, a conservative group gathered to strongly oppose its compulsory enforcement. The leader of this group was a member of the House of Peers, Nagakage Okabe. He organized scholars and lawyers who opposed the enforcement of the metric system, and published pamphlets, one of which was titled, *A Collection of Opinions against the Enforcement of the Metric System*.[15]

Its opening essay was Okabe's "Opposing the Enforcement of the 'Metric System Law' in View of the Mission of Japan." His argument against the metric system, though seemingly naïve and unpersuasive in our eyes, reflected contemporary views on the relationship between the East and the West and the particular place of Japan. Before criticizing the metric system, Okabe discussed Japan's mission as the harmonization of the cultures of the East and of the West, the Eastern culture excelling in spirituality and the Western in materiality.[16] He

14. *Kokuritsu Kagaku Hakubutsukan Hyakunenshi*, op.cit., pp. 192–201.
15. Nagakage Okabe et al., eds., '*Mētoru*' *Hō Kyōsei Shikō Hantai Ikenshū* (*A Collection of Opinions against the Enforcement of the* '*Metric System*') (1933), unpublished.
16. Ibid., pp. 1–2.

pointed to the economic crisis in America and Europe from 1929, stating that "it was caused by the decline of the spiritual culture, despite the progress of science and material world, and it has resulted in a confusion of thought and ideology, which has led many Westerners to turn to Eastern spiritual cultures." After the Meiji Restoration, Japanese eagerly assimilated Western cultures and technologies, but Okabe believed it went to an extreme. He then criticized the adoption and enforcement of the metric system, for the system embodied Western science and its emphasis on industrial efficiency. The Japanese should not easily abandon native units of weights and measures such as *shaku* and *kan*, which were linked with, and indispensable in, everyday life in Japan. He respected the Meiji rulers' decision to keep the native *shaku* and *kan* system while defining them in terms of the metric units, and he condemned the 1921 Measurement Law which exclusively adopted the metric system.

Several scholars joined Okabe's conservative group. Chūta Itō, a notable architect and historian of Japanese architecture, stated that the design and construction of traditional Japanese buildings inherently required the use of the native scale, *shaku*, especially for specifying the size of wooden props and beams. Kiyotsugu Hirayama (1874–1943), an astronomer renowned for his theory of asteroid distribution, argued that there was nothing wrong with the parallel use of different measurement systems, or the use of non-decimal systems —as witnessed by our use of two logarithms, or our way of measuring time and angles. The seven-day week was by no means rational, and yet people experienced no inconvenience. Hirayama concluded that the use of *shaku* and *kan* did not need to be replaced by the metric system, and could remain useful and convenient in Japanese daily life. In the end, the opponents were not championing the exclusive use of native weights and measures. Rather, they were objecting to the compulsory conversion of every unit into the metric system under a pressing time schedule. Moreover, they did not necessarily agree with one another on all the details; the architect and the scientist may well have rejected Okabe's grandiose ideology. But their concerted opposition exerted significant influence on politicians at the time.

In response to this conservative opposition, a group of promoters

of the metric system vigorously fought back. They edited a collection of pro-metric articles, *Opinions on the Metric System by Practical People*.[17] "Practical people" defended the adoption of the metric system against each objection raised by the opposition party. All land estates at the time were measured by the native system, and an opponent pointed out the enormous costs of calculating and rewriting all the registered numbers. But Kaichirō Imaizumi, the leader of the promotion group, estimated that the approximate cost of conversion would be around three million yen, which was within the government's capacity, and added that in any case the rewriting of the land register was not for the next year, but ten years away. Referring to the objections of the architect Itō, Imaizumi also argued that the size of wood materials could be rendered in metric terms, though not in round numbers, and that this would not in any way hinder traditional architectural construction. Another "practical man" referred to commercial reasons for adopting the metric system, stating that the adoption of the metric system would give Japan a better position to compete in trade with the United States and the United Kingdom, and to export to China and Manchuria, where the metric system was already employed.

The debate between the promoters and the opponents went to the floor of the Diet, but with no quick resolution. A few years later, the government finally decided to postpone the enforcement of the metric system until 1959.

7. Conclusion

I have surveyed the history of the introduction of the metric system from the Meiji Restoration to World War II. A notable feature of the metrological system in modern Japan was the coexistence of the three systems of weights and measures and the long persistence of the British yard-and-pound system, due to the strong reliance of Japanese

17. K. Yokoyama, ed., *Jissaika no Mētoruhō Iken* (*Opinions on the Metric System by Practical People*) (Osaka: Metoru Kyokai, 1934).

industries on British engineering. Against those who were used to the native or the British system, proponents of the metric system engaged in an active promotion campaign. And they were quite successful.

I called attention to the roles played by the graduates of the French Physics class and the Japanese Society of Weights and Measures. The French physics graduates were enthusiastic in introducing and establishing the metric system in Japan. The Tokyo Physics College they formed offered a training curriculum for the first officers at the metrological testing stations in local prefectures.

The Society of Weights and Measures was extremely active in promoting the popularization of the metric system. After the Measurement Law was established in 1921 and the metric system was formally adopted as the official unit system, the Society mobilized every effort to popularize both metric measures and, more generally, the ideology of measurement. It could be pointed out that the "time is money" ethos, so deeply ingrained in the mindset of most Japanese people today, had one of its historical roots in the Taisho era movement to improve social and domestic life and make it more efficient.[18]

Table 5.1: A chronological table of the history of metrology in modern Japan

Acronyms of the ministries
MF Ministry of Finance
MAC Ministry of Agriculture and Commerce
MHA Ministry of Home Affairs
MCI Ministry of Commerce and Industry

1869.11	Metric system under the control of the MF
1870.8	Section (MF) in charge of reform of the metric system
1871	New Coinage Law
1875	Law to regulate the metric system; MF proposed to join the treaty of international metric system but was opposed by MHA
1881	The enforcement of the metric system under MAC
1883	Committee (Ministry of Interior) to investigate the British and the French metrological systems
1885	Ministry of Agriculture proposes joining with the Convention of the Meter
1886	Japan joined the Convention of the Meter

18. See Chapter 1 on this historical problem.

1890	The meter and the kilogram standard prototype arrived in Japan
1891	The Law of Weights and Measures passed, relying on the metric system as its standard but using the terminology of the native system of weights and measures. Metric testing station was set up in each prefecture.
1892	Training would-be prefectural inspection officers in the MAC
1893.1	The Law of Weights and Measures enforced
1894	The establishment of the Great Japanese Society of Weights and Measures, which continued until 1903
1903	The Central Testing Station of Weights and Measures was established
1909	The amendment of the Law of Weights and Measures; approved the use of yard-and-pound
1911	The establishment of the Japanese Society of Weights and Measures (renamed the Japanese Society of Measurement in 1951)
1919.6	The Committee for the Investigation of Weights and Measures and Industrial Standardization was set up in the MAC
1921.4	The amended Law of Weights and Measures was passed
1922.6	The Exhibition of Measurement was held in Tokyo; the promotion film "Keitarō Nikki" attracted 30,000 spectators
1922	The Exhibition of Measurement was held in Osaka
1924	The law was enforced with a 10-year moratorium for the public sector and 20-year moratorium for others
1925	The metric system started to be used and taught in primary schools
1933.10	The Association for the Preservation of the Native Shakkan System was established
1933.12	The enforcement of the metric-system law was postponed
1938	The Committee for the Investigation of Weights and Measures was advised to admit the use of the native system
1939	The further amendment of the Law of Weights and Measures
1952	The Law of Metrology was established to enforce the metric system universally in the public from 1959

Table 5.2: Japanese native units as defined by the Law of Weights and Measures of 1891

Length		
bu	1/100 shaku	3.03 mm
sun	1/10 shaku	3.03 cm
shaku		30.3 cm (defined as 10/33m)
ken	6 shaku	1.82 m
jō	10 shaku	3.03 m
chō	360 shaku (60 ken)	109 m
ri	12,960 shaku (36 chō)	3927 m

Area		
bu or tsubo	6 shaku × 6 shaku	3.3 m^2
se	30 bu	99 m^2

Volume		
momme	1/100 shō	18.0 cm^3
gō	1/10 shō	180 cm^3
shō		1.804 liter
tō	10 shō	18.0 liter
koku	100 shō	180 liter

Weight		
bu	1/10,000 kan	0.375 g
momme	1/1,000 kan	3.75 g
kan		3.75 kg (so difined)
kin	160 momme	600 g