The introduction of the metric system to Japan

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Measurement is the basis of civilization. Uniform standard units, in turn, are the basis of measurement. It is based on such standard units that governments tax 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.

At the end of the Edo period, after U. S. Commodore Perry's arrival off the coast of Uraga, the Tokugawa government attempted 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. Opponents raised many objections and obstacles. What made the conversion especially complex was the deep 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 rivalled each other from the beginning of the Meiji era up until after World War II.

The present paper 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 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

opponents of the metric system defended native measures.[1]

The Control of Weights and Measures in the Edo Period

The system of weights and measures in Edo Japan was closely related to social structure, and the relationship between 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.

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 the central and local governments periodically inspected balances and measures in use in the town, 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 that of weight. Although the central government authorized only two *masuza*s in Edo (present–day Tokyo) 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, and some of these vessels differed 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 *shô* 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 didn't rigorously control the latter. Although there were orthodox units of length and area used in carpentry and 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.

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 to develop a new adequate system of weights and measures.

The 1870s witnessed the establishment of the International Treaty of the Metric System. The idea of international unification of 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 first International Congress of the Metric System was first held in 1870, and at the second meeting in 1875, the International Treaty of the Metric System was signed by sixteen countries.

The head of the Reform Section, Shibusawa Eiichi (1840–1931) was introduced to the metric system by the physicist Tanakadate Aikitsu (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 of the Nagasaki Naval Training School, who had been taught by Dutch naval officers and engineers. Perhaps because of such members with Western knowledge, the Section attempted in implicit fashion to make the metric system the standard. 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 real 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 Uchida Itsumi (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 standard of length, but it soon turned out that the volume measure made by this unit differed from the volume unit 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 International Treaty of the Metric System 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 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 Nakamura Seio, the physicist Yamakawa Kenjirô (1854–1931), and the mathematician Kikuchi Dairoku (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 recalled Kikuchi's report on his visit to an international conference where it was 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 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 government 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 order-made 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 Col-

lege was established by graduates of the "French physics class" of Tokyo University (the short-lived predecessor of Tokyo Imperial University, which in turn is 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 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. Takanose Munanori, for instance, was one of the founders of the Tokyo Physics College and 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.

The spread of the yard-pound system and the amendment of the law

The French physics graduates were, however, 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 first from the French army and then from the German. The navy, on the other hand, adopted the British system because of its British connection : the notable exception was the Yokosuka Arsenal, which had been founded by French naval engineers on the eve of the Meiji Restoration.

But as far as industrial technologies were concerned, 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 Department of the Tokyo Imperial University), too, was dominated by young British engineers. These British engineers naturally employed their own 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 didn't 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 only 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 was 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 very problematic in the case of railroads.

In 1909, the 1893 Law of Weights and Measures was finally amended, and the use of yard-and-pound for measurement was officially approved. The government now had also to test scales and measures based on 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.

World War I and standardization

The metric system had so far been largely promoted by a group of leading scientists with keen interest in metrology. World War I brought significant changes in the 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 or processes. The army tried to standardize the size of nails as early as 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 on the 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 waterpipes. 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 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, chaired by the Minister of Agriculture and Commerce himself. 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, electric 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 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 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. Ogawa Kiyoshi, 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 also be taken into account: if a product was still under development, premature standardization should be avoided so as not to hamper its rapid improvement; tradition should also be taken into account.[10] Reflecting the heavy influence of the U. K. and U. S. 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–pound system at the University was considered difficult in mechanical engineering and naval architecture in particular, and less problematic in civil engineering, architecture, and aeronautical engineering.

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 Imaizumi Kaichirô (1867–1941) declared that there had

already been enough discussion in the Investigative Committee, and that such summons were unnecessary. The law was passed and promulgated as a law on 11 April 1921. The day was then commemorated as the day of weights and measures. Two years later, the law went into effect.

According to the new law, two kinds of moratorium periods were set for 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, Kikkawa Shiryo referred to discussions in the United States Congress, which suggested that if the U. S. adopted the metric system, the 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 keenly aware of the need for propaganda to promote the spread of the metric system.

It had an excellent assistant, 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; it 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 *keiryô shisô* —the thought or ideology of measurement. This measurement ideology is perhaps the key word in the history of the metric system in Japan. The Society went way beyond the propagandazing for the metric system itself; it promoted a fundamental change in the way of life—the modernization of lifestyle.

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, *Doryôkô* (Weights and Measures). The winning script, *Keitarô nikki* (A biography of 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 Keitarô.

Keitarô learns about measurement and becomes fascinated with it. Returning home, he asks his mother if she has a balance at home. She answers that they used to have one, but the father sold it when the house was cleaned at the end of the last year, because they had used it only very rarely and considered it unnecessary. Disappointed, Keitarô emphasizes the importance of measurement, imitating his teacher's way of speaking, and he asks his father to buy a new balance. He and his father go to the center of Tokyo and buy one. Back home, Keitarô immediately starts to weigh everything around him, small or large, from small goods to people such as himself and the servant. Happy Keitarô goes to bed with his own dear balance.

The next day is Sunday. Keitarô continues his game of measuring all things at home. And he makes an amazing discovery. The actual amounts of sugar, *miso* (Japanese seasoning paste), and beef—all differ slightly from the amounts ordered from the shops. The next day, he and his father visit the Tokyo Metrological Bureau and observe the metrological instruments and the test conducted with them. On their way back, they purchase a set of all essential measuring devices for domestic use. The following day, shop servants show up and try to sell goods to Keitarô's family. It turned out that the liquor, the rice, the sugar, and the charcoal they have brought are actually all less than the amount they claim to be selling, so the boys from the shops are told to leave. The only exception is the boy from a meat shop who luckily had heard what was going on inside, and manages to devise cunning tactics on the spot. Keitaro's diary of that day opens 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. What was displayed in this Osaka exhibition was 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 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?" (Fig. 1). Another showed the scene of an elderly traveller arguing about the bill with the cashier of the hotel where he was staying, 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 (Fig. 2).

The exhibition on measurement held in Tokyo was part of a series of special exhibitions at the Tokyo Educational Museum, which aimed at the scientific enlightenment of the wider public. This series was organized under the leadership of Tanahashi Gentarô, 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 (World War I) and science", "Domestic science", "Time", and "The improvement of domestic life". The last exhibition, which was intended to rationalize every facet of domestic life, even 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.

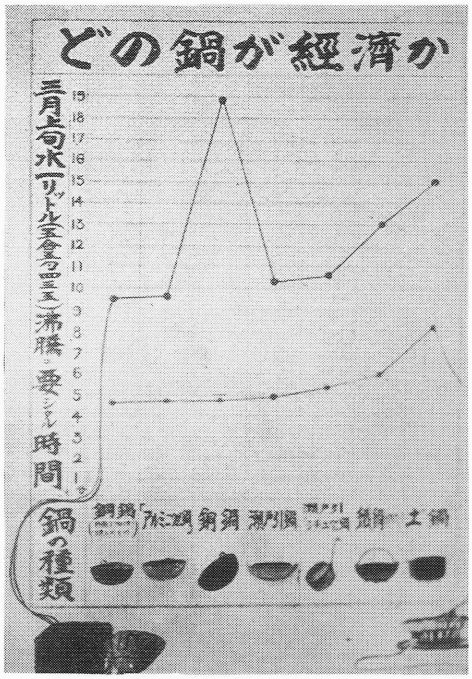

Fig. 1 A poster at the Measurement Exhibition in Osaka, with the title "Which pot is economical?"

Fig. 2 Another poster at the Measurement Exhibition in Osaka, with the title "A Penny for an Englishman."

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 oppose its compulsory enforcement strongly. The leader of this group was a member of the House of Peers, Okabe Nagakage. 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 does not seem persuasive to us today, but his words seem to reflect contemporary views on the relationship between the East and the West and the particular place of Japan. Before criticizing the metric system, Okabe explained Japan's mission as the harmonization of the cultures of the East and of the West. He first characterized the two cultures:

> Originally, Eastern culture excels in spirituality. It investigates the relative principles of Yin and Yang, and never forgets the unifying root of all things. What it states is deep and lofty, though its essence is difficult to understand. Western culture, on the other hand, turns to scientific topics. It is easy to explain and understand, but tends to be materialistic and egoistic, and runs the risk of losing the spirit of piety and sacrifice, and ignoring moral values.[16]

Okabe then pointed to the economic crisis in America and Europe (in the early 1930s), 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 assimilated Western cultures and technologies so eagerly that Okabe believed it went to the extreme. A "dark current" among the various contemporary ideologies in Japan, he considered, was the thought of scientists and industrialists who emphasized material progress and physical convenience. Against the current tendency to follow this Western materialist ideology, the Japanese now had to make every effort to unite the material-oriented culture of the West with Eastern spirituality.

In this context, Okabe sharply criticized the adoption and enforcement of the metric system, for the system embodied Western science and the emphasis on industrial efficiency. The Japanese should not so easily abandon native units of weights and measures such as *kan* and *shaku*, which were strongly 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. Itô Chuta, 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. Hirayama Kiyotsugu (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* thus didn't 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 pressed time schedule. Moreover, they didn't necessarily agree with each other 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] These essays defended the enforcement of the metric system from a variety of standpoints. The first part of *Opinions* was a collection of newspaper clippings which defended the metric system against its opposition. An article in the *Osaka mainichi shimbun* told about a diplomat in the Information Department of the Ministry of Foreign Affairs. Influenced by his friend Okabe, the leader of the opposition group, he explained all about the criticisms of the metric system to his family. His smart son, however, promptly refuted the criticisms referring to all merits of the metric system, which he had learned at school. The father was stumped.[18] After April 1925, the metric system was taught to first and second grades pupils, and by the time objections were expressed by conservatives, all primary school pupils were more familiar with the metric system than with the native or the British system. A contributor to *Opinions* made a plea not to return to the native system, so that her children would be spared the complex calculations entailed by native units.

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 Imaizumi Kaichirô, 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 Itô, 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 contributor added that with the adoption of the metric system, the size of shelves in houses would become slightly wider, and this would make storage more convenient.

The nationalist objections of Okabe and others were refuted by army personnel who pointed out that the Imperial Japanese Army had been using the metric system since its inception, and asked whether opponents considered the military antinationalist. Another "practical man" referred to strategic 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.

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 measurement system in modern Japan was the coexistence of the three measurement systems, and the long persistence of the British system, due to the heavy reliance of Japanese 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 particular 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 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 seems to me 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.

Lastly, I mentioned the conservatives who criticized the compulsory change to the metric system. Okabe, the leader of this reactionary movement, framed his criticism within a grandiose worldview of Eastern and Western cultures. The Japanese militarist government might have been expected to endorse his nationalistic ideology, but it chose instead to promote the rationalization of Japanese industries. How these two conflicting elements were reconciled in the thinking of wartime militarist leaders is a topic that remains to be explored.

Appendix 1

The chronological table of the history of metrology in modern Japan

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

1869. 11	Metric system under the control of the MF
1870. 08	Section (MF) in charge of reform of metric system
1871	New coinage law
1875	Law to regulate metric system MF proposed to join the treaty of international metric system, but 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 Treaty of Metric System Committee to investigate the metric system
1886	Joining the Treaty
1890	The meter and the kilogram prototypes arrive
1891	The Law of Weights and Measures passed: uses native weights and measures system; but metrological basis was the metric system Metric Testing Station set up at each prefecture Department of Metrology at Tokyo Physics College
1892	Training the would-be prefectural inspection-officers at MAC
1893. 01	The Law of Weights and Measures enforced
1894	The establishment of the Great Japanese History of Weights and Measures; continued until 1903

1903	The Central Testing Station of Weights and Measures established
1909	The amendment of the Law of Weights and Measures; approve the use of yard and pound
1911	The establishment of the Japanese Society of Weights and Measures (name changed to the Japanese Society of Measurement in 1951)
1919. 06	The Committee for the Investigation of Weights and Measures and Industrial Standardization set up at MAC
1919. 12	The Committee advises the unification through the metric system
1921. 04	The amended Law of Weights and Measures passed
1921. 06	The Exhibition of Measurement held in Tokyo; the promotion film "Keitarô Nikki" attracts 30,000 spectators
1922	The Exibition of Measurement held in Osaka
1924	The law enforced with the 10–year moratorium for the public sector and 20–year moratorium for others
1925	Use and teaching of the metric system at primary schools
1933. 10	The Association for the Preservation of the Native *Shakkan* System established
1933. 12	The enforcement of the metric system law postponed
1938	The Committee for the Investigation of Weights and Measures 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 : unified by the metric system from 1959

Appendix 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/ 33 m)
ken	6 shaku	1.82 m
jô	10 shaku	3.03 m
chô	360 shaku (60 ken)	109 m
ri	12,960 shaku (36 chô)	3,927 km
Area		
bu or tsubo	6 shaku × 6 shaku	3.3 m^2
se	30 bu	99 m^2
Volume		
momme	1 / 100 shô	18.0 cm^3
gô	1 / 10 shô	180 cm^3
shô		1.804 liter
tô	10 shô	18.0 liter
koku	100 shô	180 liter
Weight		
bu	1 / 10,000 kan	0.375 g
momme	1 / 1,000 kan	3,75 g
kan		3,75 kg (so defined)
kin	160 momme	600 g

Notes

1. The present paper is primarily based on the two main works on the history of Japanese metrology : Metoru hô jikko kisei Iinkai, ed., *Nihon metoru hô enkakushi* (A history of the metric system in Japan) (Tokyo : Nihon Keiryô Kyôkai, 1967) and Nihon Keiryô Kyôkai ed., *Keiryô hyakunenshi* (A hundred year history of measurement) (Tokyo : Nihon Keiryô Kyôkai, 1978). The chief editor and writer for both works is Koizumi Kesakatsu.
2. The wealth of a *han* was measured by the estimated volume of rice taxed each year.
3. *Za* had been originally meant for designated seat (*za*) for privileged tradesmen at the occasion of religious or political festivals. Such monopoly groups, privileged families, were organized on various kinds of consumer goods —oil, gold, ..., and measures. For *hakariza*, see Hayashi Hideo, *Hakariza* (Tokyo : Yoshikawa Kôbunkan, 1973), and Koizumi Kesakatsu, *Hakari* (Tokyo : Hôseidaigaku Shuppankyoku, 1982). For *masuza*, see Koizumi Kesakatsu, *Masu* (Tokyo : Hôseidaigaku Shuppankyoku, 1980).
4. The *kujira jaku* literally, "whale scale", was so called because it used to be made of a whalebone whose flexibility was apparently well 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 calculations.
6. Nakamura Seio, "Kaikodan (A Recollection)," *Doryôkô*, no. 137 (1923), quoted in *Nihon metoru hô enkakushi* (A history of the metric system in Japan) (Tokyo : Nihon Keiryô Kyôkai, 1967), 65.
7. Keiryô Kenkyûjo, ed., *Keiryô Kenkyûjo hachijûnenshi* (An eighty-year history of the Metrological Laboratory) (Nihari, Ibaraki : Keiryô Kenkyûjo, 1984), unpublished, 42.
8. *Tôkyô Daigaku hyakunenshi, bukyokushi* 2 (Tokyo : Tôkyô Daigaku Shuppankai, 1987), 336.
9. Yoshida Eisuke, "Kôgyôhin kikaku tôitsu jigyô no gaiyô (A survey of the project of industrial standardization)" *Kôgyô chôsa ihô* (Reports on industrial investigation), 1 (1923), quoted in *Nihon kagaku gijutsushi taikei* vol. 3 (Tokyo : Daiichi Hôki, 1967), 272–76, on 273.
10. The Japanese Society of Mechanical Engineering ed., *Fifty years of the Japanese machine industry* (Tokyo : The Japanese Society of Mechanical Engineering, 1949), 1099–1144, on 1106–7.
11. Tôkyôto Keiryô Kenteijo (Tokyo Metrological Station) ed., *Tôkyô no doryôkô gyôsei shiwa* (Administrative history of metrology in Tokyo) unpublished, 483. The exhibition, however, was not mentioned in the official history of the National Science Museum, *Kokuritsu Kagaku Hakubutsukan hyakunenshi* (A hundred year history of the National Science Museum) (Tokyo : The National Science Museum, 1977).
12. *Tôkyô no doryôkô gyôsei shiwa*, 484–86.
13. It was unfortunately destroyed at the great earthquake in 1923. *Ibid.*, 486.
14. *Kokuritsu Kagaku Hakubutsukan hyakunenshi*, op. cit., 192–201.
15. Okabe Nagakage et al., eds., *'Metoru' hô kyôsei sikô hantai ikenshû* (A collection of opinions against the enforcement of the 'metric system') (1933), unpublished.
16. *Ibid.*, 1–2.
17. Yokoyama K., ed., *Jissaika no metoru hô iken* (Opinions on the metric system by practical people) (Osaka : Metoru Kyôkai, 1934).
18. *Ibid.*, 4.