

West Dean College

## **Shakkanhō (尺貫法) and Kanejaku (曲尺)**

The traditional system of Japanese measurement and its use in carpentry

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*In this paper I will discuss the traditional measurement system (Shakkanhō) in Japan especially in terms of measuring length (shaku) (尺). I will include a brief history of the system, when it was used and the extent of its use in the modern day. The second half of this paper will document how shakkanhō is used in architecture, traditional carpentry and other crafts, and finally a note on the tools used in conjunction with this system when marking out timber.*

*This paper is catered for the non Japanese speaker.*

Measurement is a basis of sophisticated civilisation, giving a physical characteristic a value. Consistent standard base units are the basis of trading goods, building houses and craft. Technological advancements demand increasingly precise universal standards to continuously work towards zero error. "Measurement is the element which humanises man's environment"[10 Pg 15]

## Measurement in Japan

Shakkanhō (尺貫法) is the traditional system of measurement in Japan, the name coming from the two base units of length and weight; them being the 'shaku (尺)' and the 'kan(貫)' respectively [1][3 Pg. 97] (The current conversions will be covered later on). The measurement has its origin in China, evolving from the Chinese Chi unit of measurement which was based on the distance between the tip of the thumb and middle finger [5][6 Pg. 145][12].

Shakkanhō was widely used in Japan between the 8th - the units were adopted in 701- and the 20th century - in 1924 the metric system was introduced into Japan and largely replaced Shakkanhō [1,2]. Although before 1924, in 1886, Japan had decided to sign the 'Treaty of the Meter' - also known as the Meter Convention 1875 [3 Pg 97][4 Pg. 94]. In 1890 Japan received the protocol kilogram and meter from the International Bureau of Weight and Measures. A law was passed in Japan 1891, stating that the 'shaku' and 'kan' were to be accepted as the fundamental units, although in the same law the newly received metric standards were introduced in the form of fixed conversions of 'shaku' and 'kan' - before this law passed the value of 'shaku' and 'kan' varied a lot depending on the context in which it was being used [3 Pg 97][2][7 Pg 190]. After these measurements were given exact metric conversions they stayed more consistent and reliable.

The British 'yard - pound' measurement system was introduced and adopted in Japan in 1909 as another legal standard; this was due to a large reliance from Japanese industries on British engineering [3 Pg. 97][7 Pg. 200]. This meant after 1909 there was a coexistence of three measurement systems - Shakkanhō, Metric and British. The three different systems had been adopted differently across industries - for example - medical and pharmaceutical adopted the metric system due to the heavy reliance on German medicine. Science and army industries both also used the international metric system; whereas engineering after 1885 almost entirely relied on British engineers so the British system was used in that industry [7 Pg. 191, 192]. In 1924 the Ministry in Japan passed a law that would enforce the metric system as the one measurement system used in Japan, in public services and the education sectors this enforcement could be gradually introduced through administration. The metric system was in school textbooks by 1925. In other sectors - as previously mentioned, using 2 other systems - the change over was not well received and largely resisted against. The law was revised in 1939 to mention that some other units could be used indefinitely in some specific sectors - such as historical objects and real estate. The 'New Measurement Law' 1951 passed in Japan which would enforce the use of the metric system universally. The result of this is easy to see from the department stores in Tokyo transitioning from selling confectionary by weight in the shaku - kan system to by the gram [3 Pg. 97 - 101].

1. What are the old Japanese units like *shaku*? [Online Article] <https://bit.ly/2VXyk0S> [Accessed 19 January 2019]
2. Dean waylaid - Measure It In Japanese Part I [Online Article] <https://bit.ly/2FDbM0C> [Accessed 19 January 2019]
3. United States. National Bureau of Standards U.S. - Metric Study Report, Volume 13 (1971)
4. Bureau International des Poids et Mesures - The International System of Units (SI), 8th Edition (2006)
5. Shaku (unit) [Online Article] <https://bit.ly/2QXW8y0> [Accessed 19 January 2019]
6. Steven A. Treese - History and Measurement of the Base and Derived Units - Steven A. Treese (2018)
7. HASHIMOTO Takehiko - The introduction of the metric system to Japan

## What is a Shaku?

As mentioned previously the shaku (尺)(measurement of length) varies a lot due to the context in which it is being used, it wasn't until 1891 that it was accepted as fundamental measurement and assigned a consistent, national standard. At this point there were still many types of shaku (measuring different lengths) which tended to be tailored to the industry it was being used in [7]. A couple of types include: kujirajaku (鯨尺), kanejaku (曲尺); meaning 'whale shaku' and 'carpenter's square' (or 'metal shaku') respectively [1].

The kujirajaku (or 'whale shaku') was the standard for the clothing industry [1]. Getting it's name from the ruler used when measuring fabric which was made of baleen - the 'whiskers' (made of keratin) in a whale's mouth used to filter sea water [11][2]. A kujirajaku measures 378.75 mm (1.25x kanejaku)[1] which is length of a tailor's ruler and the width of a kimono. [2]

The kanejaku is the most commonly recognised shaku in Japan. It is equivalent to 30.3 mm or 11.93" (often referred to in English as the 'Japanese foot' due to its closeness in measurement to the imperial foot)[1][2][8][9]. Although close to an imperial foot it varies hugely by the fact it's consistently divided decimally [10 Pg 22]. The Chinese chi was shorter than this. I will refer to the 'kanejaku' as simply 'shaku' for the rest of this essay; this is normal in modern day Japan as many of the variants have become less common.

## Shaku Divisions

In contrast to the imperial foot, but similarly to the meter, the shaku is divided in base 10; meaning easy maths. I have constructed these tables using the shaku as the reference point (as the system does) - in a similar way we may use the meter now (all other length measurements are multiples or divisions of). For ease of reading I will only convert these measurements into metric.

Unit (Kanji)	Relative Value (fraction of Shaku)	Metric Value (mm)(3 Significant Fig.)
Mō (毛 / 毫)	1/10,000	0.0303
Rin (厘)	1/1,000	0.303
Bu (分)	1/100	3.03
Sun (寸)	1/10	30.30
Shaku (尺)	1/1	303

Unit (Kanji)	Relative Value (fraction of Shaku)	Metric Value (mm)(4 Significant Fig. (m/km))
Shaku (尺)	1/1	303.0
Ken (間)	6/1	1,818 (1.818 m)
Jō (丈)	10/1	3030 (3.030 m)
Chō (町)	360/1	109,080 (109.08m)
Ri (里)	12,960/1	3,926,880 (3.927km)

[1][2][8][9][10][12][13]

8. Shaku [Online Article] <https://bit.ly/2DmlHEk> [Accessed 20 January 2019]

9. Aigo Shimona - The Indigenous Japanese System of Measurement – Shaku, Sun, Bu, and Rin [Online Article] <https://bit.ly/2FCxwJN> [Accessed 20 January 2019]

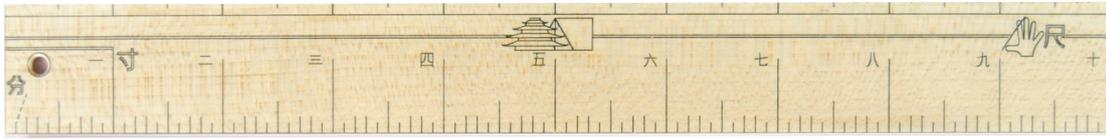
10. Heino Engel - Measure and Construction of the Japanese House (1989)

11. Marine Life Glossary: Baleen [Online Article] <https://bit.ly/2WcJJdw> [Accessed 20 January 2019]

12. Third room • Story of numbers and units [Online Article] <https://bit.ly/2HmDrEK> [Accessed 19 January 2019]

13. Unit of Measurement [Online Article] <https://bit.ly/2FBaJyj> [Accessed 20 January 2019]

The measurements mentioned in the first table above are all divisions of 10 from the shaku downwards. In exactly the same way (as previously stated) we might divide down the meter to the centimetre, to the millimetre, nanometre and so on. This part of system is similar to metric in its use as well, for example you will find a shaku (10 sun) rule (30.3cm); as we find 30 centimetre (300 mm) rules commonly available.



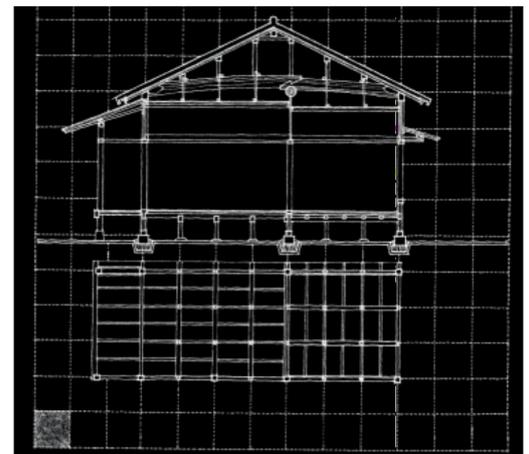
(Figure 1) "JAPANESE "KANEJAKU" SHAKU RULER" - A modern ruler made using the shaku system[14]

The second table shows the measurements larger than the shaku - these are little less simple than the base ten divisions of the smaller measurements. The ken (6 shaku) being an interesting one to mention as it likely does not originate from a smaller or bigger multiple but came into existence as an independent measurement [10. Pg. 25]. The Japanese Ken (間) was created as an architectural measurement for organising interiors and exteriors and is still used today [15]. With a basis in the height of a human the ken is used to proportion interiors, houses and land. This unit too came from China initially, and its preliminary meaning was the measurement between two columns in a room, this is still used in the same way in Japan today [16][10 Pg. 24].

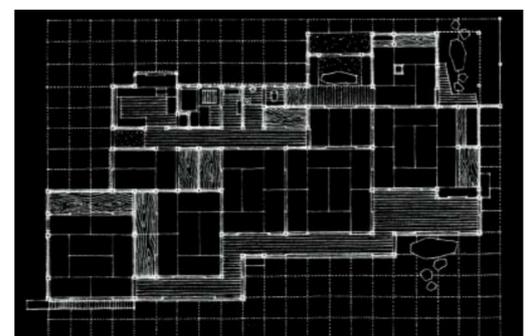


(Figure 2) Traditional Japanese tatami mats [18]

The placement of columns in a Japanese home determine the size of the kumiko and paper panels that form the partitions in the room. Another factor - and probably the most distinct feature of a Japanese home - which determines the dimensions, layout and proportion of Japanese architecture is the tatami mat (畳)(Fig 2); a type of flooring made from woven rush (or igusa) grass around a rice straw core [17][18]. Generally a tatami mat measures 6 x 3 feet which converts to 1 x 0.5 ken. These dimensions determine the size of a room, the mats are laid out in different orientations next to each other to form the entire floor. Figure 3 shows a schematic of a typical Japanese house, the grid being ken squares. This shows how almost every measurement in the house relates to ken measurements. Figure 4 is the plan view of a different house - note how the tatami layout is drawn on this house schematic; this shows not only how the measurement defines the room size but also how the interiors are considered in the earliest stage of planning. This is true for carpentry of all types in Japan and in contrast to many Western thought processes.



(Figure 3) Typical Japanese house on ken grid [15 Pg. 251]



(Figure 4) Typical Plan Japanese house on ken grid [15 Pg. 251]

When the ken measurement was first consciously applied to Japanese architecture it is said that the architecture gained its most distinguishable feature - order [10].

14. [Online Article] <https://bit.ly/2T2ZA6t6> [Accessed 20 January 2019]

15. M. Salim Ferwati & M. Alaa Mandour - PROPORTIONS AND HUMAN SCALE IN DAMASCENE COURTYARD HOUSES (2008)

16. Ken [Online Article] - <https://bit.ly/2QYqolZ> [Accessed 20 January 2019]

17. Anna Hoffman - Quick History: Tatami Mats [Online Article] <https://bit.ly/2FBIGi9> (2012) [Accessed 20 January 2019]

18. All About Tatami - Japan's Traditional Straw Mats [Online Article] <https://bit.ly/2Cyl4pn> (2016) [Accessed 20 January 2019]

The kanji symbol for 'ken', 間, is also worth mentioning - this symbol is shared with the word 'ma'. Which is the concept of the negative space between objects being the true essence of the object. It doesn't really have a direct translation although some key words could be: gap, space, interval and pause. This links together nicely with the use of ken in constructing homes, especially in the sense of orderly and minimalistic interiors.

### Tools used in conjunction with shakkanhō

In this section I will mention 3 tools used in the marking out process of timber by a traditional Japanese carpenter. Not only are these tools used in marking out and in conjunction with shakkanhō (today) but are also every day tools that will be used on every single project.

### The Sumitsubo, the Sumisashi and the Sashigane

When a Japanese carpenter is building a house they will first lay the outline with string, next they will chose the timber which will become the columns and make marks for the first cuts [19 Pg. 12]. To make these marks all three of these tools would be used. The first being the sumitsubo (ink pot) - the equivalent of a Western chalk line. A tool used to mark a straight line on timber quickly, and sometimes over a relatively long length. Rather than string and chalk used in the Western equivalent, the sumitsubo uses silk and ink.



(Figure 5) Sumitsubo and Sumisashi [20]

The sumitsubo is more than just one of the regular tools in a Japanese carpenter's tool box, it is seen as symbolic of the carpenter's spirit. The traditional carpenter - or master (shokunin) - tended to make their own sumitsubo [20] on "a rainy day or when he is between jobs" [19 Pg. 13]. Often the ink pot would feature ornate carvings on the outside - this was not only for decoration but also due to the fact that this tool is considered an important spiritual symbol [19 Pg. 13]. The sumitsubo - among other tools was often left at the temple or shrine after the construction had been completed, remaining as treasures at the site; this was an offering and a representation of the master who did the work.

The sumitsubo is used in a very similar way to how a Western chalk line would be, one notable difference being the use of ink. Sumi ink is used - made from pine charcoal and animal glue. Cotton wadding holds the ink in the bowl as the silk is passed through. This tool can yield a very thin and precise line, a skilled carpenter can even use it to mark curved lines.

19. Toshio Odate - Japanese woodworking tools, Their tradition spirit and use (1998)

20. Schtoo - Sumitsubo (ink pot) set up and use. [Online Article] <https://bit.ly/2MDSDMx> (2009) [Accessed 29 January 2019]

21. Mathieu - Using a Sumisashi and Sumitsubo. [Online Article] <https://bit.ly/2RYNIkZ> (2015) [Accessed 29 January 2019]

Used always along side the sumitsubo the next tool to mention - and arguable the most important - is the sumisashi (bamboo pen). The sumisashi is a piece of flat bamboo measuring around 9" [19 Pg. 14] with one end shaped to a flat, sharp edge for drawing straight thin lines, and the other being shaped to a narrower, less sharp point for drawing characters. The sumisashi essentially functions as a brush, the bristles being the bamboo fibres. The fibres at both ends are separated either by gently crushing the flat faces at the ends with a hammer or splitting them from the end with a knife. The separated fibres give the brush a hugely increased surface area - and therefore the ability to hold and dispense ink (in the same way as a fountain pen nib functions). The sumisashi is used with the sumitsubo - the sumitsubo as an ink pot in the carpenter's non dominant hand when marking timber. The advantages of ink over pencil include; clear and defined lines, durable marks and the ability to produce fine, sharp lines.

The final tool to mention, and again, used along side the previously mentioned tool (sumisashi), is the sashigane (carpenter's square). In a similar way to the sumitsubo the sashigane is seen an important symbol of all tools [19 Pg. 18]. The sashigane is very similar to the Western carpenter's square, made of steel and featuring measurements. The notable differences would be its cross section profile and the flexibility of the steel. The cross section is such a shape that the edge does not contact the timber in normal use - this is so the ink does not smudge; for precise work the sashigane would be tilted so the edge meets the timber. A modern sashigane will more often than not have metric graduations on the front and back, whereas the traditional version would be quite different. The traditional sashigane would feature shaku measurements on one side. These measurements start on the outside corner and are in sun (1/10 shaku). On the reverse side, one scale reads in sun  $\times \sqrt{2}$ . This is used to find the largest square stock possible to yield out of a round log. This works because a right angle triangle with 45° corners will have a hypotenuse in the ratio of  $\sqrt{2}$  to the adjacent sides (Pythagoras theorem applied to a 45 45 90 triangle). The other reads sun  $\times \pi$ , this is used to determine the circumference of a log. Because  $\pi \times \text{diameter of a circle} = \text{circumference}$ , this scale reads the distance around the outside of the log while measuring its widest point on the face.



(Figure 6) Sashigane (shaku measurement) [21]

Shakkanhō today in Japan is used mostly in the carpentry industry. Some of these measurements are so defining in design I believe it will be impossible for them to be fully faded out. A Japanese carpenter's marking tools are simple, and cheap to make - yet very precise if used correctly. This type of seemingly basic solutions to common problems is very common in Japanese craft. This, along side a respectful attitude is what makes craft in Japan so special.

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