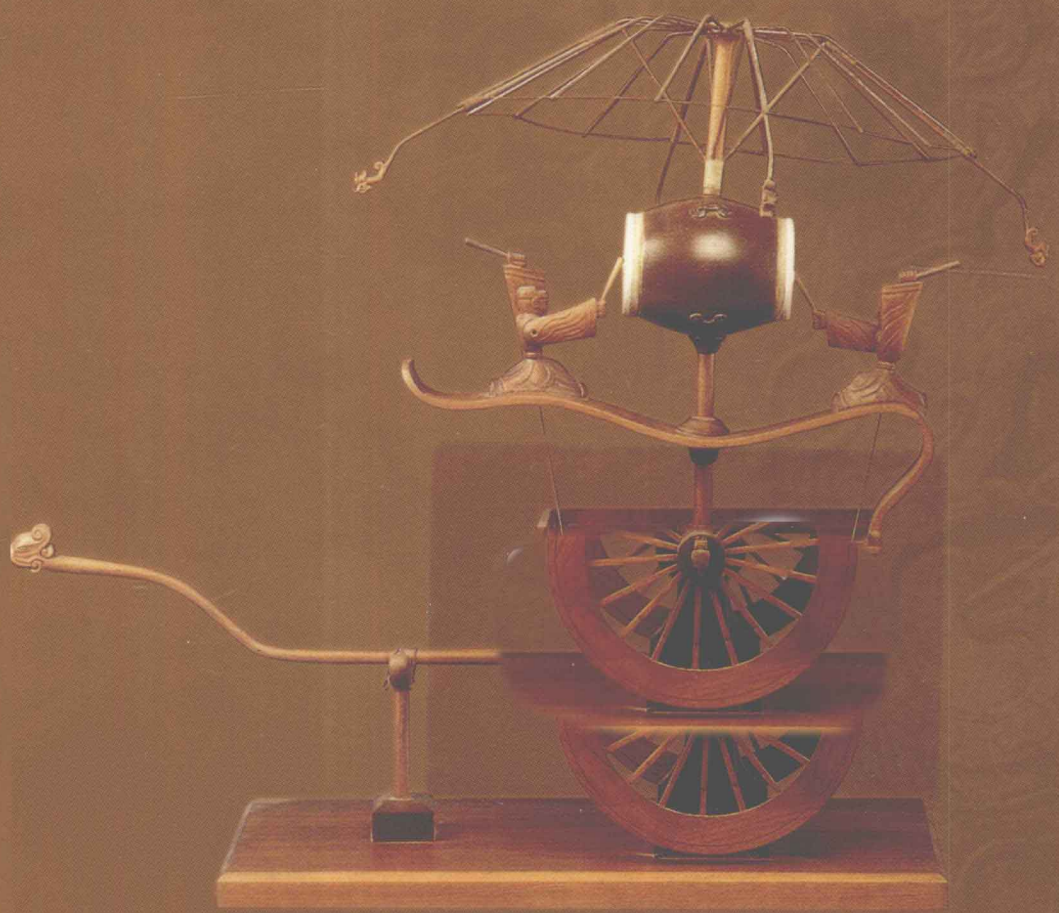
中国古代计量史

THE HISTORY OF ANCIENT CHINESE MEASURES AND WEIGHTS

丘光明 著
张延明 译



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序

计量科学源于远古，发展于现代。中华文明绵延5000年，计量技术一直与社会生产、商品交换互相促进，并成为中国科学技术发展的重要基础。

中国古代计量技术的最大特点，是受到儒家礼乐制度的深刻影响。古代经典著作《尚书》云："协时月正日，同律度量衡。"《礼记》云："周公朝诸侯于明堂，制礼作乐颁度量而天下大服。"2000多年来，度量衡的发展与乐律有着千丝万缕的联系。秦始皇统一度量衡，以乐律为基础建立起来的单位制，经过《汉书》整理成文，代代相袭，至清代仍被康熙、乾隆所遵从，甚至延续至中华民国时期。同时，由于受古制的束缚，度量衡的改制与创新皆难以被接受，如宋朝学者李照奉诏制乐秤，提出将秦汉以来的16两1斤制改为10两1斤制，以1升水之量定1斤之重，然而，这一更加科学的制度未被采纳。尽管如此，中国的度量衡制度随着时间的推移持续地发展着，最终形成了一个博大精深的科学体系，从而在世界科学技术史上占有重要地位。这部中英文对照的《中国古代计量史》，便是从这个历史宝库中精选最具代表性的器物图片，并加以扼要论述，它从一个特殊的层面反映了中华民族的智慧和对世界文明的贡献，也是与各国计量史同行进行交流的极好图书。

本书编著者丘光明女士从事计量史研究，三十年如一日，不知疲倦地搜集历史资料，研究实物器件，发表了数十篇学术论文，出版了多部专著。丘女士之所以取得丰硕的研究成果，除了她的勤奋刻苦之外，也有一点家学渊源。她的祖父是清末代进士，官至保庆知府，也是知名学者和教育家；她的父亲是一位学富五车的文史专家。这一家庭背景为她从事学术研究并取得丰硕成果创造了非常好的条件。我衷心地期望她继续努力，为这个重要的事业做出更多贡献。

是为序。

PREFACE

Metrology originated from the ancient times and developed in the modern times. Throughout five thousand years of the Chinese civilization, metrological technologies have been advanced with social production and commercial exchanges, and have laid the foundation for the development of the Chinese sciences and technologies.

The most striking characteristic of the ancient Chinese metrological technologies lies in the fact that they were influenced profoundly by Confucian rites. It is recorded in the classics of *Shang Shu* that "setting the seasons in the calendar in line with days and months; and associating the measures and weights with the rites". In *Li Ji*, it reads, "in handling with the affairs of state, Zhou Gong had meetings with the feudal princes in order to regulate rites and measures and weights, thus winning the subjects". It is evident that for more than two thousand years, the development of the measuring and weighing systems has been associated with that of rites and temperament. Qin Shi Huang, the First Emperor, unified the measuring and weighing systems, and the units were set on the basis of the rites and temperament. Sorted out and put in order in *Han Shu*, these were carried out in the following dynasties, even observed by Kang Xi and Qian Long, emperors of the Qing Dynasty, and continued till the Republic of China. Meanwhile, being bound up in the ancient systems, efforts on innovation and reformation on the measuring and weighing systems met with difficulties and were unable to be adopted. For instance, Li Zhao, a scholar in the Song Dynasty, when receiving an imperial edict to produce steelyards, advocated to change the scale of 16 liang as 1 jin prevailing in the Qin and Han dynasties to that of 10 liang as 1 jin; and set the capacity of 1 sheng of water as 1 jin. Although this was more scientific, the then government did not accept it. The Chinese measuring and weighing systems, however, developed continuously and became broad and profound scientific systems. They also play an important role in the history of science and technology in the world. This book in Chinese and English consists of precise descriptions with pictures of the most representative objects from the historic treasuries. It is from this special facet that the collections in the book reflect the wisdoms of the Chinese people and their contributions to the world civilization. The book is also a masterpiece with which people may exchange ideas with those in other countries who share the same interest in the history of metrology.

Qiu Guangming, the author of this book, is a researcher on the measuring and weighing systems for more than 30 years. She has been collecting historical data and examining actual objects, which resulted in numerous research papers and books. There are domestic origins in her scholastic endeavors: Her grandfather was a famous scholar (Jin Shi), government official and educator in the Qing Dynasty, and her father was a renowned expert in literature and history. All these backgrounds contributed to her establishments and successes in pertinent researches. I expect wholeheartedly that she will continue to make endeavors and to contribute greatly to this important cause.

Wang Daheng (Endorsement)

Foreword

THE HISTORY OF ANCIENT CHINESE MEASURES AND WEIGHTS

前言

中国古代以度量衡和时间为主要内容的计量技术，有着悠久的历史。早在父系氏族社会，度量衡和计时已是农业文明的基础。传说在黄帝时代已发明了以干支记日、月。继而尧命羲、和二人参照日、月、星、辰定历法。舜到东方巡视，在部落联盟议事时，商讨把四时之气节、月之大小、日之甲乙，度量衡之齐同，乐律声音之高低都统一起来。禹治理水患，划分九州，“身为度，称以出”，以人体建立度量衡标准。上述虽然都属后人追溯，却真实地反映了先民们的自然哲学观念。

计量制度的建立、单位标准的确定虽然都是人为的，但必须具有权威性。公元前221年，秦始皇用武力征服了各诸侯国，颁发了统一度量衡诏书，同时初步建立了一套完整的度量衡制度。后经汉代的改进、完善，成文于典籍而被历代遵循，奉为圭臬。此后每经改朝换代，都要探究古制之本，以确定当朝度量衡和计时单位标准。历代流传下来的器物不断被发现，其传承关系明确便是有力的证明。直至清代，无论是度量衡还是计时制度都是秦汉古制的沿袭，今犹陈列在北京故宫博物院太和殿前的鎏金铜嘉量和日晷便是有力的物证。

中华民族的祖先，通过长期的生产实践和天文观测，创造了里亩、尺寸、升斗、斤两等度量衡单位制和年、月、日、时、刻等计时单位。以当时先进的科学方法，制定了单位量值标准，不断完善测量器具和测量方法，使中华民族创造的物质财富和科技文明，都能在时空坐标上被定格记录下来，其量化的数据真实、可比。

中华悠久的文明史流传下来大量珍贵文物，其中有许多与计量有关的器物和文字资料，记录和讲述了一个个生动而有价值的故事。如考古学家曾统计过，在100多座春秋战国时期楚国的墓葬中，出土了数量不等的天平、砝码，它们是用来称量可切割的黄金货币的，反映了楚地盛产黄金、经济繁荣、商贾活跃的社会面貌。掌握着大量财富的王公贵族和豪商巨贾们，向往着死后升入天堂，继续过着荣华富贵的生活，天平、砝码便成为随葬品埋入地下。又如留存至今的“商鞅铜方升”，器壁刻铭详尽，其中“十八年”即器的制造年代在商鞅辅助秦孝公变法的公元前344年，是为了统一秦国度量衡而由官居卿相的商鞅亲自督造的。“十六尊（寸）五分尊（寸）壹为升”，说明当时已普遍使用“以度审容”。“齐遂卿大夫众来聘”，记录了当时重大的政治事件，同时也可能有两国共同商定有关统一度量衡的内容。公元前221年，秦始皇下诏书统一全国度量衡，又将诏书加刻在器的底部。一件量器所刻铭文，向后人讲述了秦国几百年的历史，它的重要意义远远超过了器物本身。秦始皇统一度量衡几乎是世人有口皆碑的历史功绩，秦权、秦量出土地域之广、数量之多，令人惊叹。据粗略统计，出土地域囊括了被统一的每一个诸侯国旧地，数量多达百余件。这些都展示了秦始皇统一度量衡的决心和雄才大略。

中国古代计量技术，在历代史籍中都有辑录。研究者根据文献记载，对照所能见到的器物，考释其铭文，测量其实际数值，模拟、复现其计量功能，使尘封的古老科技重现光彩。西汉末年，刘歆总结了前人的智慧，提出了一套系统的以黄钟、累黍定度量衡标准的理论，

后载入《汉书 · 律历志》。即以音频定长度，用累黍为介质加以复现。声与量皆为无形之物，量尚可通过度量衡器测量出来，而在古代，声是无法测量并保存的。如何让以黄钟定度量衡这一科学的设想得以实现，刘歆等先哲们通过反复试验后，提出以黍为介质，即选用中等大小的自然物“黍”，横排 90 粒得黄钟律管之长 (9 寸)，加一寸即一尺。律管之积约容 1200 粒黍，与一龠的容量相当，二龠为一合 (16.2 立方分)。积 1200 黍之重约 12 铢，24 铢即一两。这样便形成了一组参量公式，厘定出度、量、衡三个单位量。从此这一量化了的公式便成为其后历代制定当朝制度时可遵循的古代标准，既可以用度量衡来定律，又可以用律来校度量衡。 近现代许多学者对此做过大量的理论推算和实物验查，证明这一公式是符合物理学原理的，在一定误差范围内也是可以复现的。

中国古代许多杰出的科学家在科学实践中因离不开“时空量”的测量，都关注和研究度量衡及时间计量。如战国时的著作《墨经》，首先讨论了等臂杠杆和不等臂杠杆各种平衡的状况，对衡器的制造作了理论上的分析。不足之处是尚未以应用数学或数学语言来表达这些平衡关系。三国时期的数学家刘徽注释《九章算术》时以“新莽嘉量”与三国时期 · 魏尺度、容量作比较，得出魏尺、魏斛分别增大了 4.7%和 2.6%的结论。南朝数学家祖冲之，经反复运算、研究后，得到了精确到小数点后七位数的圆周率 (3.1415926~3.1415927)。并用它校核了“新莽嘉量”的设计数据后，指出其设计者——刘歆的数术“粗疏”。唐代在经过长期的实际运用后，把延续了 1600 多年的衡制中的“两、铢、累、黍”(非十进制)，改进为“十钱为一两”。后又经过宋代进一步完善，推出了“两、钱、分、厘、毫”皆十进制的质量小单位系列。宋代的另一特点是，众多的天文、音律、算术家以及达官显宦都参与详考古今 (宋) 计量器具。如开国之初便有刘承珪精校朝廷收支银两的各种衡器，创制了精巧的小型杆秤——戥子，重新制颁了成套标准砝码。李照研制了“乐秤”(又称水秤)，提出用 1 升水定 1 斤重的标准。司马光与范镇有关是“律生度”还是“度生律”的讨论，历时三十年，往返书信数万言。北宋科学家沈括著《浮漏仪》，将漏刻的结构及消除误差的各种措施一一记录下来。《宋史 · 舆服志》中对指南车、记里鼓车的内部结构、齿轮传动系统和机械装置作了详细的叙述。

中国近代对计量史的研究始于 20 世纪初，罗振玉、王国维、刘复、马衡、容庚、商承祚、唐兰、朱德熙等学术巨擘都先后发表了重要著作，对商鞅方升、秦权、秦量、新莽嘉量、历代尺度等作了大量考证和研究。1937 年吴承洛著的《中国度量衡史》，是中国第一部度量衡通史专著。从 20 世纪 50 年代开始，随着考古事业的发展，古代计量器具陆续出土，历史、文物、考古、古文字专家先后发表了许多有分量的研究论文。20 世纪 70 年代末，在国家计量总局及其直属单位的领导下，有了一支专业的研究计量史的队伍，此后有关计量史的论文、图书陆续出版，中国计量史成为科技史研究的一个分支，也逐渐受到国际上一定的关注。但由于汉语难学、难懂，曾有许多外国朋友来信、来访时提出，希望有一本英文版的中国计量史，简要地介绍一些有关资料供他们参考。于是笔者便产生了以图文并茂的形式编写一本《中国古代计量史》的想法。经过多年的努力，并得到国家质量技术监督检验检疫总局计量司的大力支持，终于写成该书。该书初稿完成后，又得到北京传世文化发展中心总裁李胜兵先生和安徽科学技术出版社的青睐，才被提到出版日程上来。

希望通过这本专著的出版，广大读者能给予中国计量史更多的关注，也希望引起更多国内外朋友对计量史研究的兴趣，更希望能与各国学者展开交流、切磋和合作，并盼望将来有一部世界性的比较计量史书籍面世。

丘光明

Foreword

In ancient China, there was a long-standing history in metrological technologies which encompassed time,measures and weights. As early as in the patriarchal society, time reckoning, together with measuring and weighing systems, built up the foundation of the agricultural civilization. According to legends, in the times of Huang Di (the ancestor of the Chinese people who had Yao, Shun and Yu as his successors), a technology was invented to record days and months by the Heavenly Stems and Earthly Branches. Yao ordered Xi and He to establish a calendar in accordance with the positions of the sun, the moon, stars and constellations. While taking inspection tour to the east, Shun presided over meetings with the union of tribes to discuss the unification of the four seasons, days in the months, measures and weights, and pitches in the temperament. While regulating rivers and floods, Yu divided the land into nine administrative regions (Jiu Zhou), and stipulated the lengths of the parts of his body as the standards in measuring and weighing objects. Although these are from popular legends, they reflect the natural philosophical concepts held by our ancestors.

In ancient times, although personalized, the establishment of the metrological systems and the formulation of the standards of units had to be authoritative. In the year of 221 B.C., Qin Shi Huang, the First Emperor, conquered the other states and issued an imperial edict on the unification of the measuring and weighing systems. A complete set of such systems was then initially established. After further innovations and improvements in the Han Dynasty, these systems were confirmed in written forms and then observed as the standards in the following dynasties. Whenever a change of dynasties took place, the original systems were re-examined to make sure that the standards of units were the same as before. An examination of the unearthed apparatus made in the successive dynasties offers clear evidence of such successions. In the Qing Dynasty, the measuring and weighing systems and time reckoning systems were set in accordance with those ancient systems prevailing in the Qin and Han dynasties. The Gilded Bronze Jia Liang and Sundial exhibited in the Forbidden City Museum serve as substantial evidence.

Throughout practices in production and astro-observations, ancestors of the Chinese people created such measuring and weighing units as li, mu, chi, cun, sheng, dou, jin, and liang; and time reckoning units as year (nian), month (yue), day (ri), hour (shi) and quarter (ke). In setting up the standards of units, advanced scientific methods were implemented, and the production and methods of measuring and weighing apparatus were continuously improved. These represent the material treasures and scientific and technological civilization created by the Chinese nation. They have been recorded throughout the history. The data are quantized and comparable.

In the long history of the Chinese civilization, valuable cultural and historic relics have been handed down in large quantities. Among the materials and written data, there are numerous records that tell us vivid and interesting stories. For example, archaeologists have had statistics that lots of balances and weights were unearthed from more than one hundred tombs of the Warring States. They had been used in the State of Chu for weighing gold and currencies. This shows that the State of Chu was abound in gold; the economy was prosperous; and commercial activities were lively. The unearthed materials demonstrated that the rulers and the rich who controlled the wealth had balances and weights buried with them, intending to maintain wealth and status in the netherworld. Another example is the Shang Yang Tong Fang Sheng, a bronze apparatus of capacity produced by Shang Yang, which is kept till present with carved descriptions in details, showing that it was made in the "Eighteenth Year (of Qin)" when Shang Yang was assisting Qin Xiao Gong the Prince in his Reformation in 344 B.C. This demonstrated clearly that in order to unify the measuring and weighing systems, it had to be done with the supervision of an official of high rank—as high as

Qing Xiang (equivalent to the rank of Prime Minister). The statement of "16 cun and 5 fen as 1 sheng" illustrated that the method of "determining the capacity by measures (of lengths)" was adopted. The statement of "Officials (Da Fu) from the State of Qi arrived in large groups" showed that it not only recorded a significant political event, but also indicated possible meetings at a high level to discuss and decide on unifying the measuring and weighing systems in the two states. In 221 B.C., Qin Shi Huang issued his imperial edict on the unification of the measuring and weighing systems and required that the edict be carved at the bottom of each apparatus. An apparatus, with descriptions telling the stories of the State of Qin lasting a few hundred years, carries a significance that is much greater than the apparatus itself. Qin Shi Huang was credited for unifying the measuring and weighing systems. Over largely spread areas of land in China, weights and weighing apparatus made in the Qin Dynasty have been unearthed in great quantities. Based on rough statistics, the areas cover all the states unified by the State of Qin. All these revealed the vision and determination of Qin Shi Huang in unifying the measuring and weighing systems in his unified China.

The metrological technologies in ancient China were kept in the historic records in every dynasty, which allows researchers to compare the historical references with real objects that can be found, study the carved descriptions, measure the actual values, and to simulate and resume their functions, thus demonstrating the glory of the ancient sciences and technologies. During the last years of the Western Han Dynasty, Liu Xin, a scholar of Confucian classics, collected and collated the wisdom of his predecessors, and put forward a theory of setting the standards of the measuring and weighing systems by the length of Huang Zhong (a pitch pipe) and by lining up pieces of corn millet, which was recorded in *Han Shu / Lv Li Zhi* later on. This was the resonation of the technologies of determining lengths by audio frequencies and by lining up corn millets as the medium. Sound and capacity are intangible, while capacity can be determined by apparatus. However, in the ancient times, sound was unable to be kept after being determined. It was definitely a challenge for Liu Xin to actualize the scientific assumption of determining measures and weights with the help of Huang Zhong. After countless experiments, Liu Xin suggested taking millets as the medium, namely, selecting 90 pieces of corn millet of medium size as a natural object, and line them up to reach the length of Huang Zhong (9 cun). One chi was reached by adding on 1 cun. The volume of the pipe was some 1,200 pieces of corn millet, which was about the capacity of 1 yue. And 2 yue was equal to 1 ge (c. 16.2 cubic fen). The sum of 1,200 pieces of corn millet had a rough weight of 12 zhu, and 24 zhu was equal to 1 liang. Thus an array of equations with referencing values was formed that determined the values of the units of measures and weights. From then on, these quantitated equations were used as standards in the following dynasties. The temperament was able to serve to determine the measures and weights, and vice versa. Many scholars in modern times, after examining the actual objects and making theoretical calculations, have verified that the equations are tally with principles in physics and the experiments can be resumed within close tolerances.

In ancient China, there were many outstanding scientists who paid close attention to time reckoning and the measuring and weighing systems throughout their researches and related activities which were inseparable from measuring "time, space, and capacity". In the classics of *Mo Jing* published in the period of the Warring States, lever principles were studied and described, which led to further theoretical analyses of the production of weighing apparatus. However, there existed shortcomings in the descriptions that were short of terms in applied mathematics to depict the interactions in balancing. While annotating *Jiu Zhang Suan Shu*, Liu Hui, a mathematician in the times of the Three Kingdoms, compared the units in "Xin Mang Jia Liang" with those of the lengths and capacities in Wei of the Three Kingdoms, and found out that the values of chi and hu in Wei increased 4.7% and 2.6% respectively. Zu Chongzhi, a mathematician of the Southern Dynasty, after countless calculations, reached the value of Pi more accurately with 7 digits after the decimal point (3.1415926-3.1415927). Further more, he cross-checked the data in "Xin Mang Jia Liang" and pointed out that there existed careless omissions in the data presented by Liu Xin. In the Tang Dynasty, after applications for

1,600 years, such units as liang, zhu, lei, and shu in the weighing systems were converted to the decimal systems, thus making 10 qian equal to 1 liang. After further improvement in the Song Dynasty, an array of units for smaller values in the decimal systems, namely, "liang, qian, fen, li and hao" was advocated. It is worth mentioning that in the Song Dynasty, government officials joined in astrologers and arithmeticians in examining the existing measuring and weighing apparatus. Take Liu Chenggui as an example, during the early years of the Song Dynasty, he collated very carefully various types of apparatus used for weighing silver in the Imperial Court and invented a delicate lever scale called Deng Zi, and produced a new set of weights for it. Li Zhao invented Yue Cheng which was also called Water Steelyard. He advocated a standard of taking 1 sheng of water as 1 jin. It took Sima Guang and Fan Zhen some 30 years to debate on whether "measures (were produced) after temperament" or "temperament (was produced) after measures". In the Northern Song Dynasty, a scientist named Shen Kuo wrote *Fu Lou Yi* (a kind of clepsydra) that recorded the structures of the apparatus (Lou Ke) and methods applied to diminish instrumental errors. In *Song Shi – Yu Fu Zhi*, the internal structures, including the gear systems and the machinery mechanisms, of the Compass Chariot (Zhi Nan Che, literally South-Pointing Vehicle) and the Drum Chariot (Ji Li Gu Che, literally Mileage-Reckoning Vehicle) were depicted in details.

Researches on the history of metrology began in the early years of the 20th century. Such authoritative scholars as Luo Zhenyu, Wang Guowei, Liu Fu, Ma Heng, Rong Geng, Shang Chengzuo, Tang Lan, Zhu Dexi and so on published a good number of pertinent works which examined Shang Yang Fang Sheng, weights and weighing apparatus in the Qin Dynasty, Xin Mang Jia Liang, and measures in the past dynasties. In 1937, Wu Chengluo published *The History of Chinese Measures and Weights*, which was the first monograph on the comprehensive history of measures and weights in China. Along with the development of the archaeological excavation since the middle of the 20th century, more and more ancient apparatus for measures and weights were unearthed, which was followed by numerous publications of research papers written by experts on history, cultural relics, archaeology, and paleography. Towards the end of 1970s, a team was built under the leadership of the National Bureau of Metrology with a mission of conducting researches on the history of measures and weights, which resulted in publications on research papers and books in this area. Gradually a branch appeared in the research of the history of science and technology and caught attention from other countries. Owing to the fact that the Chinese language is difficult to learn and understand, there have been lots of requests by foreign friends and researchers to get hold of a book in English on the history of Chinese measures and weights, and to provide them with some materials as references. Hence I had an idea of compiling a book with illustrations to be entitled *The History of Ancient Chinese Measures and Weights*. After years of endeavors, and with the support from the National Bureau of Quality Inspection, and from the Section of Metrology, I was able to present a draft of such a book. Thanks to Mr. Li Shengbing, Managing Director of Beijing Traditional Cultural Development Center, and publishers of Anhui Science and Technology Publishing House, who appreciated and valued the works, the publication of this book became possible.

It is my hope that the book will draw closer attention from readers on the history of Chinese measures and weights, and will raise greater interests from foreign friends in researches on the history of metrology. I also hope that this book can serve as an instrument to promote exchanges of perspectives and approaches in this area. I expect to see a book on comparative metrologies of the world in the near future.

Qiu Guangming

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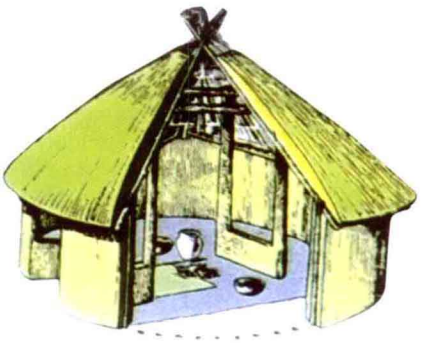
THE HISTORY OF ANCIENT CHINESE MEASURES AND WEIGHTS

中国古代计量史



一、原始的数量和时间概念

Chapter One

The Primitive Concepts About Quantity and Time

中国计量史的特点，在于它的独立性和连续性，很少受到外来的影响。清朝末年到中华民国(1875 ～ 1949)，为了与世界接轨，政府开始改革传统的制度，提出采用米制。经过不断的努力，最终在原有的基础上，采用最简单的换算而达到了逐步向米制平稳过渡。

这里说的计量，包括度量衡在内的其他测量，如时间、湿度、温度、风向、风速等。在中国古代，度量衡专指长度、容量、质量(重量)三个量。古代度量衡，其单位制基本上沿袭了秦代(前 221 ～前 207)所确定下来的制度，又经过汉代完备地记于史籍。几千年来，尽管朝代更迭，但总是在继承的基础上求改进。汉代的长度单位是分、寸、尺、丈、引。1 引＝ 10 丈＝ 100 尺＝ 1 000 寸＝ 10 000 分。容量单位是龠、合、升、斗、斛。1 斛＝ 10 斗＝ 100 升＝ 1000 合＝ 2000 龠。重量单位是黍、累、铢、两、斤、钧、石。1 石＝ 4 钧，1 钧＝ 30 斤，1 斤＝ 16 两，1 两＝ 24 铢＝ 240 累＝ 2400 黍。

新石器时期陶器残片上常见有记数的符号
Recurring symbols of numbers on pottery remnants in the New Stone Age

A longitudinal view of the Chinese measures and weights reveals their conspicuous features of independence and continuity in their historical development. In Chinese history as long as several thousand years, measuring and weighing systems have developed free from external interference. During the last years of the Qing Dynasty from 1875 to 1949, the traditional Chinese systems began to undergo a process of transformation with the goal of adapting the metric system. This process was basically completed in the Republic of China (1912-1949), when a set of methods of conversion was designed and widely accepted.

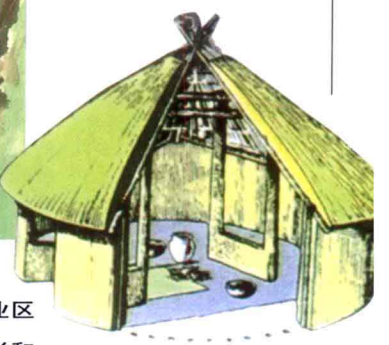
In this book, "measures and weights" means not only the measuring of length, capacity and mass (in ancient China, there was no differentiation between mass and weight), but also that of time, humidity, temperature, wind direction, wind speed and so forth.

Units and their fractions in the measuring and weighing systems were designated and set in the Qin Dynasty (秦代，221B.C.-207B.C.), and recorded systematically in books in the Han Dynasty (汉代). Throughout the history ever since, with dynasties changed, units and their fractions set in the Qin Dynasty and perfected in the Han Dynasty were basically followed, although there existed improvements.In the Han Dynasty, units and their fractions in the linear measures comprised fen (分), cun (寸), chi (尺), zhang (丈), and yin (引) .1 yin =10 zhang, 1 zhang =10 chi, 1 chi = 10 cun, 1 cun = 10 fen. For the measures of capacity there were yue (龠), ge (合), sheng (升), dou (斗), and hu (斛) .1 hu =10 dou, 1 dou = 10 sheng, 1 sheng = 10 ge, 1 ge =2 yue. For the measures of weights there were shu (黍), lei (累), zhu (铢), liang (两), jin (斤), jun (钧), and dan (石) .1 dan = 4 jun, 1 jun = 30 jin, 1 jin = 16 liang, 1 liang = 24 zhu, 1 zhu = 10 lei, 1 lei = 10 shu.

新石器时期的七孔石刀，孔距均匀，孔眼相当，是经过比较测量的
An unearthed seven-hole stone chopper in the New Stone Age, with the holes regularly distributed, showing evidently the application of measurement

母系氏族社会村落遗址复原图。房屋大小适当，排列有序

Shelters, with appropriate sizes and regular arrangement, erected in a village ruins restored from the matrilineal commune times



计量活动是用数值来表示事物的量。因此最早的测量是在学会记数之后才开始的。原始人群通过劳动、生活和分配，对数和量逐步有所认识，并产生了表示数量的方法，如结绳记事和按量估堆等。人类对长度的测量，大约是从天然洞穴里搬迁出来，靠自己的双手建造房屋时开始的。在陕西省发掘出多处母系氏族社会村落遗址，其中半坡是典型的一处，分居住区、手工业区和公共墓地三部分。居住区房屋式样有方形和圆形，经实地观测，设想当时人们在动工前已有了布局规划，并确定朝向、间距以及测量每座房屋的面积等。其中一间大房子可能是公共活动场所，它每一边的长度约略相等，是当时经过测量的实证。

Measures and weights have been used essentially as numerical values to represent quantities of objects. So the measures and weights came into being after people had learned the way of counting. Primitive people became aware of numerical and quantitative values through their experiences of labor and life, thus starting to count numbers and estimate quantities in very simple ways, for example, to tie knots in a cord to count numbers and to pile objects to estimate quantities. After they moved out of natural caves and began to build shelters, people learned gradually the method of linear measures. Relics of villages inhabited by the people then showed matriarchal commune patterns, which were unearthed in Shaanxi Province. They were typical ones of those villages that consisted of the residential quarters, handicraft quarters, and cemeteries. Seeing from the layout of houses in a residential area, we realize that before the construction started, people had made the plan in which measures must play an important role. In the residential quarters there was a big house that was probably used as a public building. The fact that the four sides of the big house were almost of the same length can be served as a proof that the concepts of measurements were applied in practice then.

新石器时期陶器残片上已有排列规整的几何图形

There existed geometric figures spread evenly on pottery remnants in the New Stone Age