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Review Article

Clock-Makers and Time-Theoreticians: Between Europe and China from the 17th Century till the Present Day

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Abstract

Surprisingly, the invention of mechanical clocks remained a European monopoly for some 500 years. The ideas of time-measurement evolved, and technical problems were solved, centres of clock-making developed in Portugal, England, France, and Switzerland which are described here. With pre-modern global travel, and the ensuing colonization of South-America, India, and Asia, the clock - in its myriad shapes and sizes - spread to these distant areas. This essay focuses on China from the year 1644, beginning of the Qing dynasty to the present day. The first gifts of precious clocks to the Emperors have been admired, and studied in detail by later technicians and craftsmen alike, and ultimately copied. In comparison with the production of porcelain, and its international trade, clocks and watches follow a similar pattern: from unique hand-made items to mass production pieces, sales via a world-wide network, and highly prized exclusive products for the rich and famous. Today, in the mass production of watches, China plays a key role: some 80% of the market is in Chinese hands, from cheap watches, parts and assemblage, to (copied) brand-products. The Confucian scholars appreciated beauty, quality, diligence, and fairness; however, the modern Chinese customer has translated these values to material cultural standards, and gives a primacy to gold.

Keywords: Astronomy; Watch; Clock; Material Culture; Ideas; Europe-China Network

Quote from Su Shi (苏轼 1037-1101), 但恐岁月去飘忽,, 寒灯相对记畴昔, Dan kong suiyue qu piaohu, Han deng xiangdui ji chouxi. But I fear that the years will pass away quickly, near the flickering oil-lamp I remember the past [1].

Introduction

For thousands of years, time-measurement in China was performed by means of sundials (日晷 Rigui) [2]: the main periods of the day being: Daylight, Noon and Night. Later, a combination with a water-clock (水钟 Shui zhong) was realized [3], and the day was split-up in twelve two-hour parts. After the 16th century and initial contacts with western nations, a Chinese awareness was sought to be answered: How can China reset the 'Lunar based concept' into a modern 'Solar based concept' in order to plan seasonal festivals, ancestor-worshipping, and socio-political events [4]. In general China in the 17th and 18th centuries was closed for foreigners in the early Qing dynasty (清朝 Qingchao 1368-1648) with the crucial Emperors: Kang Xi (康熙 r. 1661-1722, Yongzheng (雍正 r. 1722-1735), Qianlong (乾隆 r. 1735-1796). They were obsessed by modernization of the 'Middle Kingdom' (中王国 Zhong wangguo), and a connection with the rest of the world - to reset clocks. The western scientists, both in materials and mechanics, hand-in-hand with skilled craftsmen, introduced, time-measurement devices - clocks and watches - after a historical process of development. The focus is on excellent art-works and their creators. The economics and ethics of this industry will be discussed as well through a cultural anthropological approach where - in a more philosophical way - Scientific Knowledge or Principle (Gr. epistēmē) and Technology (Gr. techne) will come together.

Contacts between China and the West-Astronomy

China has a long tradition of observing 'Space' (空间 Kongjian) and the 'constellation of the celestial bodies' (天体的星座 Tianti de xingzuo). In the Shang Dynasty (商朝 Shang chao 750 BC-1122 BC) already early knowledge of the 'Mansions' (宫 gong) or 'fixed constellation of stars' (twenty-eight Zodiac stations) can be found on the 'oracle bones' (甲骨 Jiagu). The 'Mathematical classic of the gnomon and the circular paths of Heaven' (Zhou Bi Suan Jing 周髀算经) is a document of early science from the Han Dynasty (汉朝+ 206 BC-220 AD) variations of planetary revolutions, although its description that the Moon's path as an ellipse - just the way the Greco-Romans thought it to be - , and the path of the Sun as 'the figure of a rope coiled about a tree' did not make for easy science, until, as Nathan Sivin (1931, Xiwen 席文, American Sinologist) remarked, 'cosmology was omitted [5]. Slightly later, Su Song (苏颂 1020-1101 AD) philosopher

and engineer of the Song Dynasty [6] (宋朝 Song chao 960-1279) developed a water-powered-clock with an early 'escapement' mechanism (擒纵机构 Qin zong ji gou) to quell its energy and make it more accurate [7]. The invention, originally from the Tang Buddhist monk Yi Xing (一行 683-727) in 725 AD was discussed by Su in his 'Treaty on the clock tower' (新仪.象法要 Xinyi Xiangfayao). These aspects merit more attention because early Jesuits (耶稣会士 Yesu hui shi) valued them in a patronising way, according to the British expert on Chinese science and technology, Joseph Needham (1900-1995, 李约瑟 Liyuese) who gives credit to the Chinese for being the most accurate observers of the Universe, however, Standaert explains how serious the misunderstandings between Chinese scholars, and Jesuits - on Biblical grounds - were regarding the calculation of the 'history of the world' [8].

Along the different 'Silk Roads' (丝绸之路 Sichou zhi lu) over land and sea since the European Middle Ages there was a continuously growing contact with foreigners, of whom the Venetian Marco Polo 马可·波罗 Ma ke·bo luo 1254-1324) was an early traveller. The books of the Assyrian, (Arabic) Middle Eastern, and early Christian scholars in arithmetic and astrology were studied intensively: Plato, Aristotle, Ptolemy, and the Arabic scholar Khwarizmi [9]. They disputed intensively on religion, philosophy, and science, and promoted respect, and further study. Later, religious men of India [10] and Medieval Europe helped to further the knowledge of the Chinese, be it with a tinge of pseudo-scientific or occult, tantric knowledge [11]. In Europe after the 15th century (western) Renaissance (文艺复兴 Wenyi fuxing) the old knowledge was found of immense value to start understanding the outer world and mechanisms of the rotating earth and planets. To mention the giants in cosmology (宇宙学 Yuzhou xue) the names of Copernicus, Brahe, Keppler, Galilei, and Newton suffice for this essay.

Especially with the insights of Galilei (1564-1642 加利利 Jia li li) and his controversies with the Vatican (教廷 Jiaoting) in 1615, and with Jesuits such as Robert Bellarmine (1542-1621 罗伯·白敏 Luo bo·bai min) [12] as antagonists, the switch was finally made from a geocentric to a heliocentric worldview [13]. This being a 'time' dominated religious-political issue, the Chinese scientists as rational materialists with regard to 'matters of Heaven and Earth' did not follow the western arguments. It was the astronomer and graduate of the Han Lin Academy (翰林院 Hanlin yuan) Ruan Yuan (阮元 1764-1849) who said: 'The laws are always changing ... I don't know where the reasons lie.' He then concluded that 'heavenly laws are so profound and subtle that they lie beyond human ability.' Theories should therefore express certainties rather than search for reasons. Only in this way can theories 'last forever without error'. Consequently, the Chinese did not establish a structural view of Nature that substantially requires 'reasoning' as embraced in Western science. In other words, the Chinese did not attempt to make systematic connections between natural principles that people experienced; they 'had sciences but no science, no single concept or word for the overarching sum of all of them' [14].

This science was brought to China by the learned priests of the Christian order of the Jesuits who appreciated the humanistic method of enquiry. Among them came Adam Schall von Bell (1591-1666, 汤若望 Tang ruowang), (Figure 1) mathematician, and astronomer, and Nicolas Trigault (1577-1628, 金尼阁 Jin Nige), with similar interests. Matteo Ricci (1552-1610, 利玛窦, Li madou) was one of the first missionaries to arrive from Italy to work in Macau. He translated the works of Euclid (ca. 300 BC, 欧几里得 Oujilide), a Greek mathematician. The clock Ricci took to China can be regarded a symbol for the 'wake-up call' of his Christian message. However, to prevent the expulsion of the Jesuits, in 1668 the Emperor demanded that Christian astronomers engage in a test with the Chinese astronomers to predict a lunar eclipse. The Belgian priest and scholar Ferdinand Verbiest (1623-1688, 南怀仁 Nan Huairen) proved to be better able to predict the phenomenon, besides more accurately track the path of the Sun, and determine the position of the planets [14]. This was his introduction to the directorship of the Imperial Bureau of Mathematics, and in 1669, the Beijing Observatory (天文台 Tianwentai) was redesigned and refitted under his supervision.

Historically, the development of astronomy (天文学 Tianwenxue) and astrology (占星术 Zhanxing shu) have been closely related throughout the world, in China, however, the two have always retained links far stronger than in Europe where they have largely been regarded as completely separate disciplines since the eighteenth century. Today, astronomy is recognised as a scientific discipline based on the rational observation of objects and events beyond the earth's atmosphere. In China, however, the signs of the Sun, Moon, and planets have always been valued when estimating the fate of human beings, through the Zodiac signs (十二生肖 Shi'er shengxiao), and metaphysical signs. The situation in China regarding technology after 1950 is best summarized in Needham's catalogue [15].

Portugal

After the Portuguese found the sea route to the East in 1513 and for this achievement cartography, nautical techniques, and astronomy, based on a thorough understanding of arithmetic was essential [16]. Commissioned by the Catholic King Pedro II (佩德罗二世国王 Pei de luo er shi guowang), they made a fortune through trade and soon their knowledge of navigation and the exotic East spread to other seafaring countries [17].

In the 16th century, Portugal had a strong industry in clock-making [18]. It was the Portuguese Jesuits Gabraël de Magelhães (1610-1677 加布里埃尔·德·马盖尔汉斯 Jia bu ai'er. De. ma gai' er han si) a skilled clock-maker, but more so Tomás Pereira (1646-1708 徐日生 Xu Risheng) later working at the court of Emperor

Kang Xi, who both advanced the science of clock-making and repair of the numerous donated clocks and 'automatons', in China [19]. Three episodes of interactive relationships between the West and China regarding clock-making will be explored, interspersed with social-cultural events such as wars, and personal or familial occurrences in the international horological scene.

The First Episode (1500-1750): Looking East

The trade with China from Europe, via Macau and Canton was organised by the East India Companies (东印度公司 Dong yindu gongsi) of Portugal, The Netherlands, England, Belgium, France, Germany, and Sweden [20]. The focus was mainly on the trade in tea, spices, and porcelain. The interest for clocks was recorded when Matteo Ricci arrived in Macau in the 1580s: someone mentioned his chiming clocks (自鸣钟 ziming zhong, lit. self-awareness clock), as objects of exotic fascination. Besides, Chinese saw clocks not as time pieces per se but rather as decorative items and status symbols [21].

The countries involved tried to break Chinese rules regarding limited entrance (isolationism 孤立主义 Gu li zhu yi) and organized several 'Embassies' to discuss the opening up of the trade with the Emperor in Beijing (or Peking). The list of these Embassies starts with: The Netherlands (Nieuhoff 1665), and England (Macartney 1793). In a different way France was influenced by the reports of the Jesuits in China, condensed in the 'Description de la Chine et de la Tartarie Chinoise' [Description of China and Chinese Tartary], edited by Jean-Baptiste Du Halde (1674-1743, 杜赫德 Du he de) 《中国描述与中国历险记》"Zhongguo miaoshu yu zhongguo lixianji"). The gifts of the Netherlands and Britain are listed in their reports and (if relevant to the subject) summarized here. The discussion on the scientific discovery of China and the trade (from the Dutch perspective) can be read in Blussé's book [22].

The Netherlands

The Dutchman Jan Huygen van Linschoten (1563-1611, 范林斯霍滕 Fan lin si huo teng) had gained much information about the passage to the East-Indies during his Portuguese service (Figure 3). In 1595 he published a book about it [23], and this pointed the way to the East along the Cape of Good Hope, which led to the establishment of the Dutch East India Company (VOC, 荷兰东印度公司 Helan dong yindu gongsi) in 1602. The first 'Embassy' (使馆 Shiguan) to Beijing was led by Johan Nieuhoff (1618-1672, 约翰·纽霍夫 Yuehan·niu huo fu) (Figure 4). His most remarkable performance was the pictorial account of the journey [24]. His report in several places mentions a '(bell) tower'. The Chinese had a long-standing knowledge of bronze making [25], but no mechanical device had been observed operating these bells as clocks, apart from hand-driven ceremonial hammers or beams, as is still seen today in temples. It was Athanasius Kircher (1602-1680, 阿塔纳奇欧斯·基尔学 A ta na qi ou si · ji' er xue), who described huge bells - the Bells of Beijing and Erfurt in Germany are compared, (Figure 2.) - in his book on China [26], which is an Addendum of Nieuhoff's 'Embassy' (p. 103).

Figure 1: Left: Adam Schall von Bell in 1618 left for China on a Portuguese ship with a group of missionaries supervised by Nicolas Trigault. Right: Emblem of the Portuguese 'Armillary Sphere' (浑仪 Hunyi) on a dish of Chinese Jingdezhen Blue & White porcelain, early 16th century.

On one tower copper bells are described on the corners "which, when the wind blows among them make a very pleasant jingling murmur." (p. 104).

The report also makes some detailed observations: "China is full of brave and well-built (square) towers (apart from the pagodas) whereof some are nine stories high, many of which are only for ornament, but upon a great part of them called 'ceuleu' [鼓楼 Gulou, drum-tower] stand their 'clocks' (pp. 195, 277, and 377), and in others, especially at Nanking, are kept the astrological instruments; upon the clock-house turrets stands an instrument, which shows time of the day by means of water, which is running from one vessel into another, raises a board, upon which is portrayed a mark for the time of the day; and you are to observe, that there is always someone remaining there, to take notice of the passing of the time, who at every hour signifies the same to the people beating upon a drum, and hanging out a board with the hour writ upon it in large golden letters. This time-drummer likewise gives notice of the discovers of any fire … etc." (p. 394).

Further remarks are made of (water) clocks: "Near Hinghao, Fukien province … in the palace is a great wonder taken notice of, for infallibly there is heard a noise against wind or rain, like unto the sound of a clock, of which (although diligently enquir'd after) no natural reason can be given" (p. 203). And, "In the province of Kiangsi … runs the river … from which the Chinese fetch the water which they use in hour-glasses instead of sand, because this water is of all others the least subject to alteration either of time or weather." (p. 206).

Johan Maetsuyker (1606-1678 约翰·马特索科尔 Yue han · ma te suo ke er), governor-general of Batavia (巴达维亚 Badaweiya), the Eastern Office of the VOC (Jakarta, in present Indonesia), on the 20th of July 1655, wrote his evaluation of the Embassy [27]. Most important is the comment in the Addendum of the Account given as [Kircher appendix] Chap. VIII. 'Of the correction of the Chinese calendar, and how much good redounded from thence' (pp. 383-389). He already felt that 'setting the clocks' could be of enormous impact for the Asian world.

On behalf of the VOC Nieuhoff's legation which visited the Chinese court in Beijing had to establish trade relations on the South China coast, however, due to the sensitive issue of the 'kowtow' (叩头 Koutou, kneeling down), the legation did not raise the subject of trade. Finally, the Emperor agreed to allow a Dutch Embassy to the court once every eight years. In addition, it was also stipulated that the Embassies concerned could not consist of more than a hundred men. The Embassy then left for Canton, after being ordered to leave Beijing on October 16, 1656, to report to the Governor General, in Batavia.

Figure 2: The bronze bells in Nieuhoff's Account.

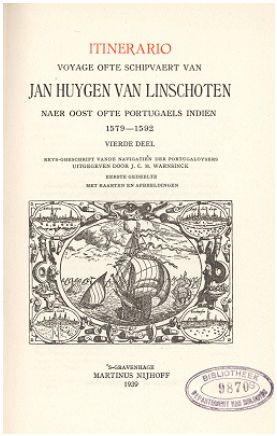

Figure 3: Left: The Itinerario of Van Linschoten to Portugal's Indies.

Figure 4: Right: The Account of the Embassy of the Dutch United Provinces (VOC).

Knowledge of the Universe developed rapidly towards the end of the 17th century and the Dutch lay-astronomer Eise Eisinga (1744-1828 艾斯·埃辛加 Ai si·ai xin jia) was capable of constructing a Planetarium (天文馆 Tianwenguan) in his own tiny house in the Frisian Town of Franeker (弗兰克 Fulanke) (Figure 5).

Figure 5: Planetarium of Eise Eisinga, Franeker, The Netherlands.

Famous are moreover the Dutch Pendulum Clocks, with weights, spring, and escapement. Reinier Plomp is a well-known modern specialist on the subject [28]. It was the Dutch scientist, politician and poet Christian Huygens (1629-1695 克里斯蒂安·惠更斯 Ke li si di an·hui geng si) who invented the 'pendulum clock' (摆钟 Bai zhong), a major advance in the accuracy of clocks [29].

In Maetsuyker's account we find 'A catalogue of presents which the Hollanders brought to China' (p. 311), however, no mention is made of clocks. The State of Holland supported many inventions in clock-making and some industrial activities between 1770-c. 1890 e.g., the Frisian Tail Clock, 弗里斯兰尾巴时钟 Fu lisi lan weiba shizhong) Figure 6, and in the Zaan region 1680-1730 (Zaanse clock 桑斯时钟 Sang si shizhong) Figure 7. These clocks were made to the guilds' tradition and were expensive. Soon, however, all types of workers joined the new clock-making industry and due to their assiduity, social coherency, and rather inexpensive raw materials, clocks became cheaper. Through their networks the reliable timepieces spread quickly to all levels of Dutch society.

Figure 6: Left: Frisian Tail Clock with weights and pendulum, and ships on the moving 'sea' above the dial. **Figure 7: Right:** Zaanse Clock with characteristic copper weights.

In 1795, Isaac Titsingh (1745-1812 伊萨克·蒂进 Yi sa ke·di jin) [30] represented Dutch and VOC interests in China on the last Embassy of the Netherlands (1793-95) with Andreas Everardus van Braam Houckgeest (1739-1801 安德烈亚斯·埃弗拉杜斯 An de lie ya si·ai fu la du si) as his second man [31] (Figure 8). The mechanical clocks ('horologies') and automatons he offered to the Emperor were most probably from a French artisan, considering the luxurious state.

Figure 8: Statuette, probably of Braam van Houckgeest. Rijksmuseum, Amsterdam BK-1976-49. Attributed to Chitqua, a Guangdong artisan, ca. 1770 unbaked clay, oil paint, h 36,5 cm × b 31,5 cm × d 20,0 cm [32].

England

After Portugal and Holland, England got also engaged in the trade with China, in part due to its major national debts [33]. Primarily, it was active in India, and colonised that continent, however, soon its ships (Indiamen) appeared in the Chinese harbours. To start with, England didn't have the wealth of Portugal, or the Netherlands. To improve that situation Sir George Macartney (1737-1806 乔治·马卡特尼 Qiao zhi·ma ka te ni) was sent on the first British Embassy to China in 1793, to promote trade with the British East India Company [34].

Macartney's report said: 'Due to the increasing trade imbalance between China and Great Britain, impelled by the latter's great demand for tea, porcelain, and silk, the British tried to address the trade deficit by showcasing their technical products, such as clocks, [35] telescopes, weapons, textiles, and others, so as to motivate the Chinese to purchase more British commodities, as well as demonstrate the utility of British science and technology'.

The Emperor then presented me with a Ju-eu-jou (九九如意 jiujiu-ruyi) object of green stone (possibly a jade sceptre) as the symbol of peace and prosperity, and expressed his hopes that my sovereign and he should always live in good correspondence and amity; at the same time, he very graciously received from me a pair of beautiful enamelled watches set with diamonds, which I had prepared in consequence of the information given me, and which, having looked at, he passed to the Minister" (p. 360, Vol. I). These watches probably were the products of the relatives of François-Justin Vulliamy [36] (弗朗索瓦·贾斯汀·弗里亚米 Fu lang suo wa·jia si ting fu li ya mi) belonging to a distinguished family of clock-makers of Swiss origin, and their founder François-Justin, settling in England about 1730 (Figure 9). Their son, Benjamin, carried on the business, and he is chiefly known for excellent regulators and ornate clock cases…." (p. 360).

Figures 9 & 10: Table Clock, Benjamin Vulliamy, London No.266 Circa 1793; detail of the Armillary Sphere [37].

To reduce the trade deficits, England had to export its own products: silver, or from India: opium. The opium caused a much direct physical harm to the Chinese people, and as a consequence to the Chinese economy. Only after two Opium Wars (1839-1842, and 1856-1860 鸦片战争 Yapian zhanzheng) China's fate turned for the better - O, "Perfidious Albion" (after Marquis de Ximénès, 1793).

With the administrators George Staunton and John Barrow; two medical doctors; the painter William Alexander (1767-1816 威廉·亚历山大 Wei lian·ya li shan da); James Dinwiddie with his fellow scientists, including Catholic priests as interpreters, the mission of this Embassy was one hundred people altogether. Access to the harbour of Canton was the primary goal, a meeting with the Emperor the second. The gifts, as said, mainly products of technology, were given to the Emperor, at the harbour of Tianjin (天津市), near Beijing [38]. Macartney arrived in Northern China in a warship with a retinue of 95, an artillery of 50 redcoats, and 600 packages of magnificent presents [39] that required 90 wagons, 40 barrows, 200 horses, and 3,000 porters to carry them to Beijing.

The British Embassy has also detailed information in the Accounts on 'measuring time [40].' Analysing the text regarding 'towers' along the (water) road, it shows 27 in Vol. I, 12 in Vol. II, and none in Vol. III. Among all these there is only one 'supposed belfry' (p. 143, Vol. I), again no mention is made of any mechanism to measure time, the rest are mainly watch-towers. About the 'making of bells', an analysis gives a description of the metals used, viz. copper, zinc, tin, iron, and bits of silver (p. 540,

II), and the immense bell in Beijing is presented again as a striking example (p. vi, Vol. II). The British scientists conclude, in this context, that Chinese metallurgy is an advanced technology.

The notes on 'time and time measurement' are interesting: In general, there are three ways to measure time: "with a liquid as in a water-clock, with sand as in an hourglass, and with a taper of a special tree with the pith, which so evenly burns that 1/12th part of it equals two hours" (pp. 538-9, Vol. II). And, "To announce the hour even in Beijing they have no better way than that of striking with a mallet upon a large bell a number of blows corresponding to that of the hour" (p. 539, Vol. II). The intervals of day and night, the period of the moon, the period of twelve full moons to a year is discussed in detail with respect of the "careful and accurate observations condensed in 60-year cycles" (p. 560, Vol. II) [41].

"The Chinese have no characters, to express numbers in an abbreviated manner, such as the Arabic (or Roman) figures used by the Europeans, but they use alphabetic writing" (p. 560, Vol. II). In 'Traditional Chinese Timekeeping', the day has twelve 'earthly branches' (地支 Dizhi) of 2-hour periods. During daylight (時-刻 shi-ke) the sundial, and during the night (更-點 Geng-dian) the 'watchman' (守望者 Shouwang zhe) in the drum-tower marks the time [42]. This figure of the watchman functions in many a story and poem, between the 17th and 19th centuries. In fact an agrarian (lunar) calender, with Zodiac signs, rules China till the present day for all kind of festivals, next to the official (solar) Gregorian calendar.

Taken on a yacht trip around the palace, Macartney stopped to visit 50 pavilions, each "furnished in the richest manner . . . that our presents must shrink from the comparison and hide their diminished heads," he later wrote [43]. Immediately, the Chinese labelled his mission as a "Tribute," and the Emperor refused to listen to British demands. It was a mistake the British diplomats didn't know that 'to look after an aged person' (and give a clock, as a metaphor for aging) meant also 'to arrange a proper burial after he dies', as the Chinese saying (成语 chengyu) goes 'yang lao song zhong (养老送终, lit. end-of-care). So, a clock was a taboo gift for the Emperor's 70th birthday! This was confirmed in the hidden 'signs of life and death' on the clocks in the 'Forbidden City collection'. The Eight Immortals (八仙 Baxian) of Taoist thanatic tradition, or a happy life: 'Queen Mother of the West' (西王母 Xi Wangmu), giving peaches (蟠桃 Pantao), the characters for 'Happiness and Longevity' (福寿 fu shou), or a crane, deer, bat, goat, the phoenix, and dragon are animals of Longevity. Similarly, apes offering gifts, (artificial) flowing water, and urns on top of the clocks as a decorative motif [44]. Summa Summarum, both the Dutch and English Embassies to China are considered by Patricia O'Neil as 'missed opportunities [45].'

The case of the Chinese astronomy was discussed as follows: "However imperfect in the science of astronomy the Chinese are, they have some idea of imaginary circles in the Heavens, such as the ecliptic ('Yellow Road' 黄道 Huang dao), the Equinoctial, and the Meridian line. The constellations, or clusters of stars, are not represented by fanciful resemblances, but connected together by lines upon their charts. The number of planets known to them is five, which corresponds to that of the elementary substances, they postulate in the composition of all bodies; namely fire, water, earth, wood, and metal, over each of which a planet is supposed to preside. Few Chinese seem to have any idea of the earth's motion; but imagine that the sun actually moves through the fixed stars. Four points in his course along the Yellow Road are particularly distinguished, as marking the four seasons of the year. The day is divided, …, into twelve parts only, consisting each of two European hours; the first beginning at eleven at night (pp. 558-9, Vol. II)."

The gifts were transferred to the Forbidden City (紫禁城 Zijincheng) in Beijing. Here were twenty-seven workshops/ateliers [46]: for cast bronze, (ceremonial) scepters, art glass, clocks and watches, maps and drawings, cloisonné enamel, helmets, jade, gold and filigree, guilt work, gears, ink rubbings, marquetry, tin work, ivory carvings, wood carvings and sculpture, lacquer work, automatons, incense sets, lacquered boxes, carpentry, lanterns, artificial flowers, leather work, mounting of pearls and jewellery, metal gear, weapons, glasses, and optical instruments. It was the intention to learn from these products: materials, processes, arithmetic, skills, measuring, and control of the technology, etc.

In Beijing a 'clock-maker's workshop' was founded to repair the clocks, take them apart and learn how the mechanism(s) worked. It is known from the documents that several timepieces from the workshop later had English, French, and German mechanical clocks incorporated into Chinese frames [47]. The principal idea was to symbolize the cooperation with Europe in the field of technology and the modernization of China. Soon European countries started to export their luxury products, the Chinese Emperor(s) as well as Mandarins and wealthy business-men appreciated the iconic products. In the meantime, China went through a period of wars with England and other nations, and was forced to open up and reflect on their position to trade more fiercely [48].

The Second Episode (c. 1750-1949): The Chinese Trade in Clocks

An early start for clock-making in Europe could be Giovanni di Dondi dell'Orologio 乔凡尼·唐迪·德尔奥罗洛焦 Qiao fan ni·Tang di· De'er ao luo luo jiao) of Padua who built in 1364 an 'Astrarium' or astronomical clock (天文钟 Tianwen zhong) as he understood that the measuring of time and the constant movement of celestial bodies went hand in hand. In the beginning of the 15th century with 'mainspring and fusee' (发条和保险丝 Fa tiao he bao xian si) portable domestic clocks were produced in Italy, France and Germany.

Switzerland

In Switzerland, Jehan-Jacques Blancpain (宝珀 Bao po) started clock-making in Villeret (1735); Abraham Favre (法夫尔 Fa fu'er) in Le Locle (1737) started a similar business with his sons; and Pierre Jaquet-Droz (1721-1790 皮埃尔·雅克·德罗兹 Pi ai'er·ya ke·de luo zi) in Chaux-de-Fonds (1738). Around 1755 watch-making in Geneva started with Jean-Marc Vacheron (1731-1805 让-马克·瓦什隆 Rang-make·wa shen long) the founder of the Vacheron-Constantin Group (瓦什隆·江诗丹顿 Wa shen long·jiang shi dan dun), the region we now generally call the Swiss 'Watch Valley' [49].

After the 'Edict of Nantes' (1598 南特令 Nan te ling) was withdrawn in 1685, hundreds of French Huguenot-Christian (胡格诺 Hu ge nuo) watch-makers fled for religious freedom reasons to England and Switzerland; they were intelligent, zealous, and entrepreneurial people, who appreciated family life. In Switzerland a 'Fabrique' (factory) and 'Cabinets' (workshops) were established for watch-making and merchants. Neuchâtel, La Chaux-de-Fonds, Fleurier, and Lelocle in the Jura grew, whereas Geneva diminished. In 1776, Jaquet-Droz went to Geneva to work on 'automatons' (自动机 Zidong ji), seemingly self-operating machines [50] for the Chinese market, as well as gold watches, with enamelled floral motifs, and a pearl trim. In the end of the 19th century watches and clocks were lighter, smaller, more accurate, and articles of luxury (豪华 Haohua). Alongside these entrepreneurial characters, the Jaeger-Le Coultre (积家 Ji jia), and Patek Philippe (百达翡丽 Bai da fei li) firms were founded, the handwork was soon carried out by machines, and the Swiss appropriated half of the world's production of watches.

France

Ferdinand Berthoud (1727-1807 费尔迪南·贝尔杜 Fei er di nan·bei'er du) settled in Paris (1753) to write many theoretical books on horology. He was befriended with the enigmatic Enlightenment (理性时代 Lixing shidai) philosophers Jean-Jacques Rousseau (让-雅克·卢梭 Rang-ya ke·lu suo 1712-1778) 'citoyen' of Geneva, who roamed around (无依之地 Wu yi zhi di) in his beloved Jura region, and Voltaire (1694-1778 伏尔泰 Fu' er tai). The creation of timepieces fitted in perfectly with their epoch and philosophy of life as time was fit for a change i.e., the French Revolution (1789-1799 法国大革命 Faguo dageming). In 1755, the famous Abraham-Louis Breguet (1747-1823 亚伯拉罕·路易·布雷盖 Ya bo la han·lu yi·bu lei gai) went to France from Neuchâtel, and in 1795 he created the 'tourbillon' (陀飞轮 Tuo feilun), which counters the effects of gravity by placing the pallet fork, balance wheel and hairspring within a cage to improve the accuracy of pocket watches. That mechanism today is seen as one of the most difficult to manufacture. Breguet integrated the 'lever escapement', which in fact was invented by the British watch-maker Thomas Mudge (托马斯·马奇 Tuo ma si·ma qi) in 1755. The tourbillion can be seen as a 'complication' (orig. French word, 并发症 Bingfa zheng) such as the moon phase, alarm, minute repeater, perpetual calendar, or chronograph, and it combines complexity of thinking with ingenious material design.

A full overview of the technology of watch and clock-making in the 18th century can be found in the 'Encyclopedia des Arts…' (百科全书，或科学，手工艺的详细解释字典 Baike quanshu, huo kexue, shougongyi de xiangxi jieshi zidian) of Diderot and d'Alembert [51]. From a sociological point of view, rebel Voltaire started a watch-making workshop in Ferney in 1760, and in Geneva a further 600 unemployed watch-makers found a job at that time. In 1775 Jean-Antoine Lépine (1720-1814 让·安托万·勒平 Rang · an tuo wan · lei ping) improved the strength of watches by means of 'bridges' to fix the moving parts [52].

England

A clock-maker of Dutch origin, Ahasverus Fromanteel (1607-1693 弗罗曼特尔 Fu luo man te' er) created, in collaboration with Huygens (see above), the first pendulum clocks in England [53]. He was a 'brother' of the 'Clock-makers Company' in Norwich, and later moved to London where he started two workshops with his son John to make his invention a success. When he moved back to Amsterdam, his three children continued his work, in the setting of an international company [54]. Among the outstanding English clock-makers was James Cox (c. 1723-1800 詹姆斯·考克斯 Zhan mu si·kao ke si) [55]. He called himself a goldsmith who "Makes Great Variety of Curious Wares in Gold, Silver and other Metals. Also, Amber, Pearl, Tortoiseshell and Curious Stones" (Figure 11 and 12). In his workshop he employed between 800 and 1,000 workmen in 1750 for export clocks. His name was visible as a brand name on every watch with enamelled dials. From the mid-1760s, he produced lavishly ornamented articles, for the trade with China, where the reception of his 'sing-songs' (歌钟 Ge zhong), as the Chinese are believed to have called them, was a great success.

Some of the automatons, one in the form of a chariot pushed by a Chinese attendant, were gifts to the Chinese emperor Qianlong, who had a special fondness for clocks, of Western origin. A ban on Cox's luxury goods for China, meant that his mechanical pieces and jewellery were guaranteed a place in museums, such as The Metropolitan Museum, the Palace Museum in Beijing, and the State Hermitage Museum in Saint Petersburg, and he sold part of them. His catalogues were published in 1773 and 1774.

Figure 11: A nice example of a Cox's watch with a Peacock (孔雀 kong que) - Chinese symbol of dignity and beauty - in the cartouche. When activated, the rosettes spin within the rotating frame on the dial of this watch, which is pavé-set with paste jewels.

The loss of a reliable trade with China, together with the fact that Cox never achieved royal patronage and suffered from the ill effects of the American Revolution on British foreign trade, precipitated his bankruptcy in 1778. The remaining stock from Canton, China, was sold in London at Christie's Auction on February 16, 1792, but in the meantime Cox and his sons, one in Canton and the other in London, resumed business, and again began sending watches to China, this time mostly made by the Swiss firm of Jaquet-Droz & Leschot [56].

Figure 12: A typical "toy": a necessaire and watch by Cox (Walters Art Museum, Baltimore, MD, USA); Nr. 57 in Clocks and watches of the Qing Dynasty, dated 1765, London.

France

Clock-making in France was established especially in Palais Royale of Paris (巴黎皇家宫殿 Bali huangjia gongdian) where among others Jean-Antoine Lépine (see above) [57] was an influential artisan-technician. He lived near Geneva and later moved to Paris to work with André-Charles Caron (1698-1775 卡伦 Ka lun), at that time clock-maker to Louis XV. In 1762 he became a master horologist, and Abraham-Louis Breguet (see above) was his apprentice. Brequet's major inventions were improvements of the so-called 'gear train' of the watches, his handsome steel-blue hands were his trademark. In 1766 Lépine was appointed watchmaker to King Louis XV of France. For a while he cooperated with the French philosopher Voltaire on employment in the 'Manufacture royale' where Voltaire lived. He paved the way for the plain pocket watch and industrial watch-making, at a time when most (expensive) watches were hand-made. This was an aspect of his philosophical and anti-luxury stance against the extravagant life-style of the elite in the French pre-revolution epoch [58]. The Lépine-calibre watch reduced a watch's thickness, used Arabic numerals, and focused on the aesthetic design. All these inventions are still used in watch-making today.

Switzerland

In horology, many innovations were introduced after the initial years in the Alps. The Frenchman Jean Toutin (1578 - 1644 尚·图汀 Shang·tu ting) improved the technique of enamel painting of miniature cases and dials (1632). His compatriot and celebrated enameller Pierre Huaud (1612-1680 皮埃尔·休 Pi ai er·xiu) was granted residency by becoming a 'citoyen' of Geneva. In that time, Le Locle (in the Neuchâtel region) was home to 41 watchmakers, 14 goldsmiths-casemakers, 5 enamellers, 6 spring-makers, 1 chain-smith, 9 engravers, and 600 lace workers. The Swiss watch-maker Breguet (see above) in Neuchâtel developed many inventions including the flat balance-spring with one or two terminal coils, that are elevated over the plane of the rest of the spring, known as the 'Breguet overcoil'.

In 1774, Pierre Jaquet-Droz, with his son, and the clock-maker Jean-Frédéric Leschot (1746-1824 尚·弗雷德里克·莱斯肖 Shang·fu lei de li ke·lai si xiao), already famous for his gold watches with enamelled floral motifs and pearl rim, presented three anthropomorph automata, called 'The Writer (Figure 13) [59], The Musician and The Draughtsman', in their workshop in Geneva. In this context it is worth noting that the French physician and philosopher Julien Offray de La Mettrie (1709-1751 拉·美特利 La·mei te li) published his book "L' Homme Machine" [Man is a Machine《人是机器》Ren shi ji qi], a work of materialist philosophy in the 18th century.

After that they promoted the products through their networks throughout Europe. In 1775, London was one of the most important centers of clock-making in the 18th century, and Jaquet-Droz met clock- merchants specialising in the China-trade. Among them was James Cox, whose son worked in Canton. After that, Jaquet-Droz started a workshop mainly for the China market. During the years 1781-1810, some 430 items were sold and shipped to China alone (watches, automatons, snuff boxes, singing birds, vials and temples). Their catalogues mention material, mechanism and decorations, including enamelling, precious stones, singing birds or musical airs, in fact precious pieces for the nobility and well-to-do bourgeoisie. Leschot shipped them to Canton via London. Later, the group moved to Geneva. After a recession due to the French

Revolution, a restart was a challenge. The connection between Switzerland, England and China is obviously a natural one for the sea-trade, however, for intellectual and financial exchange, this Anglo-Swiss trade requires yet further research.

To make the step from Switzerland into China, in the new age, the personality of Gustave Loup (1876-1961 古斯塔夫·卢普 Ga si ta fu·Lu pu) should be noted [60]. Loup was a Swiss merchant born in China who spoke fluently French, English and Mandarin. His father was one of the watch and clock-makers who left the Val-de-Travers in the 19th century to settle in Canton, Shanghai and Tianjin where he sold watches. It was some time during the 1920s that this expatriate opened a business trading in antiquities between China and Switzerland, and started a shop, called 'La Chine Antique' (Ancient China) in Rue Céard in Geneva. The business thrived for some ten years until the Japanese military presence in China (1937-1945 中国抗日战争 Zhongguo kangri zhanzheng) rendered purchases and exports impossible. Loup ended his life in Geneva, in his house packed with European and Chinese antiques, and his famous watch-collection, which he purchased in China and brought back to Switzerland, covering the Golden Age of 'La Montre Chinoise' (the Chinese watch) (1790-1860) [61]. Loup started a correspondence with Alfred Baur (1865-1951 阿尔弗雷德·鲍尔 A'er fu lei de·Bao'er) [62], a collector of Asian antiques, in 1923, who was able to preserve numerous items of Loup's rich collection. These precious artefacts later formed the basis of the 'Baur Museum of Far Eastern Art' (鲍氏东方艺术馆 Bao shi dong fang yishu guan) in Geneva [63].

Figure 13: 'The Writer' automaton by Jaquet-Droz, with detail of the mechanic work in the back.

The European Watch for China

Any historical overview of global watch-making has to include the personage of Eduard Bovet (1797-1949 爱德华·播威 Aidehua·Bowei) and his family. He was born in Fleurier, Switzerland, and with two brothers started a London Firm called the Magniac Co. (马尼亚克 Ma ni ya ke). Around 1815, the workshops of Piguet & Meylan, Jaquet Droz & Leschot in Geneva, Ilbery in London, and the Bovets stand out for the quality of their sophisticated creations, and over the years millions of watches were sent to China (Figure 14). In 1818 two Bovets moved to Canton (present-day Guangzhou) in the 'China Watch Trade', one brother continued production in Fleurier, and another transferred to Macau. In the meantime, Eduard was involved in 'Republican' politics in the Rousseauian opinion with the Hohenzollern Monarch of Prussia (who then possessed the Neuchâtel region), and consequently moved to France. In 1836, a nephew took over in Canton while 175 people continued to produce the elegant timepieces and music boxes in Fleurier. The so-called 'Chinese watch' is an iconic flagship product of watch-making at the turn of the 19th century, enhanced by elaborately engraved and enamelled embellishment of gold and surrounded by pearls. At its peak around 1840, the Chinese trade, although disrupted by the Opium Wars, continued with Switzerland. Edouard Bovet's influence is such that the Brand name "Bo Wei (播威)" in Cantonese vernacular means the product (watch) itself. Wrongly signed "Tevob" (i.e., the syllables Bo - vet in reverse 威播), the case proved that it was worthwhile adopting and familiarising a name as it is pronounced in Mandarin (Figure 15).

Figure 14: Oil-Painting of the harbour view of Canton in the 19th century, with the Hongs (háng 行 i.e. warehouses) of France, America, England and Holland.

The British 'Treaty of Nanking' (1842 南京条约 Nanjing tiaoyue) that ended the First Opium War enormously increased the revenues of the Bovet Watch Cie. The firm was then passed to the Leuba Brothers (1901), Ullman & Co (1918), and Favre-Leuba (1948). In 1966 the enterprise stopped its production in Fleurier. In 1989 Michael Parmigiani (1950- 米歇尔·帕玛強尼 Mixie er pa ma qiang ni) continued the Bovet Company, and left the name and trademarks or intellectual property (智慧产权 Zhihui chanquan) with the Bovet Fleurier Corporation [65]. After the 'quartz crisis' (石英危机 Shiying weiji) he returned to traditional watch-making, moreover restoring antique timepieces (恢复古董钟表 Huifu gudong zhongbiao) was a new goal. As a result of his perfect work on the unique watch collection of the Swiss 'Sandoz family' (桑多斯家庭 Sangduosi Jiating) his name became a brand. The Bovet epic name was relaunched in 2007 in the 13th century Castle of Môtiers, Val de Travers, Switzerland.

Figure 15: Three BOVET pocket watches for the Chinese market [64]. Right: Note that the name BOVET (播威 Bo wei) is given in reverse 威播 (Wei bo) (see text).

The 'Hall of Clocks and Watches' (钟表大厅 Zhongbiao dating) in the 'Fengxian Palace' (奉贤宫 Fengxian gong, earlier called 'Palace of Ancestor Worship,' 1656) in The Forbidden City is home to the collection of Qing Dynasty timepieces. This includes about 200 clocks and watches mostly made in Switzerland, England, France, and Japan, which had been presented to the Emperor or purchased; the China-Made timepieces, in the 'Imperial Workshop' 造宗处 Zaozongchu, in Guangzhou, and Suzhou, are especially remarkable, but to date, information on these workshops about these clocks is scarce. Who were the craftsmen employed there, and how about any European assistants? What kind of mechanisms, decorations, and further hardware were included? [66] The clocks and watches display various styles, exquisite workmanship, and their artistic value makes them very unique. One of the clocks is a chiming clock, made about 1797, by the Imperial clock-makers. The clock is 5.85 meters high and it stands on a 2.6-meter-high square base. It can still run up for to 72 hours after it is well wound up, regularly striking hours and quarters [67].

Chinoiserie, and the 'new China'

In the 18th century a period of Chinoiserie (中国风 Zhong guo feng) i.e., the European style in the artistic idiom of China as found in the colors, material, figures, and natural objects such as pagodas became a dominant theme in architecture, art, furniture, clothes, jewellery, and gardens.

Figure 16: Chinoiserie clocks, from left to right: a. Clock, turquoise enamel ground and depictions of cranes, ducks and birds in foliage and reed, the dial with roman numerals signed 'V. J. Magnin Guedin & Co.', San Francisco, CAL, USA. b. Edwardian bracket or mantle clock in a decorative case, with German movement. c. A 1920s mantel clock, with a rectangular silver plated and chased face with circular dial and Roman numerals. The red lacquer case has a raised decoration and gilded highlights, a pagoda top with brass carrying handle, and French movement. d. Edwardian mantel clock housed in a decorated case on a green ground with typical Chinese scenes standing on a raised, stepped base and surmounted by a pagoda top with vase finial. Made by 'Astral' (H. Williamson Ltd since 1871), Coventry, silvered dial signed 'Mappin & Webb, London, c.1910.

In the newly developed Chinese world of the 19th century, the clocks were also integrated in architecture, interior design, and personal lifestyle. In the 1860s in Hong Kong, two clock towers were built in the city. Also, the 'HK Jockey Club' (香港赛马会 Xianggang saima hui) was marked by a clock on top of the building (p. 388), and the 'Bremen Club' had a 'grandfather's clock' (祖父的钟 Zufu de zhong) (p. 390). Further, in Canton the water-clock was a focal point (p. 684), however, later it was reported that the old water-clock was damaged in the last British attack on Canton. The reporter wrote: "It was an interesting relic of the past. It consisted of three vessels ranged one above the other. The time was indicated on a brass rod, which rose out of the lowest of these as the vessel filled with water received in a uniform tickle from those above it (p. 784)." Finally, on the Shanghai Bund (外滩 Waitan), the 'Customs House' (江海关大楼 Jiang haiguan dalou) had a square clock tower (p. 684), (Figure 17) [68].

Figure 17: Left. The Bund, Shanghai. Customs House (**江海关大楼** Jiang haiguan dalou) with Bell Tower, 1925. The five bells were cast by Taylor's from Loughborough, UK. Architects Palmer and Turner, 1927; Right: Former Kowloon Canton Railway Clock Tower (**前九广**铁路钟楼 Qian jiu guang tielu zhonglou), 1915.

A golden watch was a token of friendship, when in Hong Kong a Mr Wong Hien Chang who was director of the Chartered Bank, the National Bank of China, and the Sassoon Bank, retired in 1907 [69]. In Shanghai, around that time, Mr. Tong Chong Leong, a fifth-degree scholar-official or Mandarin (**官**话 guan hua), lived with his family in the Residence called "Taiping Lee" on the Woochang Road. He studied in California, and was Director of Dodwell & Co. (**天祥洋行** Tian xiang yang hang) in Shanghai. In the traditional living room, an impressive clock stood right behind the House Altar and Ancestors' tablets (Figure 18) [70].

Figure 18: A clock as a decorative piece (left) in the Mansion of the Family Tong Chong Leon (see text).

The Third Episode: 1955-2020, Horological products 'Made in China'

After a long period of international politics of colonialism, and a cataclysmic period of Mao Zedong's (1893-1976 **毛**泽东) Socialist Education Movement (1963-1966 **社会主**义教育运动 Shehuizhuyi Jiaoyu Yundong), and Proletarian Cultural Revolution (1966-1976 **无**产阶级文化大革命 Wuchan jieji wenhua dageming) China recovered, and became stable enough to focus on the new era (Figure 19). An introduction for this period on the situation in China regarding the subject 'scientific thought and technology' after 1950 is best summarized in Needham's catalogue [71].

Figure 19: During the Cultural Revolution c. 1970: (left) no watches yet for masses, but for some soldiers (right).

Vintage Chinese watches

Initially, modern watches and clocks have been imported to China from the West, however, several western factories (and their China-based branches) are known to have produced series of watches for the local and extended Far Eastern market, initially usually luxury products for the wealthy. One such factory is the Swiss Blancpain since 1735, and recently part of the International Swatch Group (**斯沃琪集**团 Siwoqi jituan). Chinese developments in the 19th century made home production of watches possible. However, the question remains: are these authentic Chinese watches? First, it can be confirmed that many watches have been designed and produced worldwide over the years, [72] however data about China failed. By order of the Chinese Government c.q. the Communist Party a national initiative was started in 1955 to establish a watch-making industry in Tianjin (**天津**, also Tientsin) in North-Eastern China. A handful of people in a small workshop, equipped with limited tools, set out to create China's first mechanical wrist watch. Completed by the 24th of March of that year, the Wuxing ('Five Stars', related to the philosophical term 'Five Elements' (**五行** wuxing), was a hand-made, uncomplicated watch, which only achieved in very limited production. Another early model was from the Wuyi Watch Factory (劳动节 Laodong jie 5-1 i.e., May or Labor Day). The 1965 production of the ST5 movement with 19 rubies (called 'diamant' 红宝石 hong bao shi, but 'jewel' 钻 "Zuan" on the watch) was the first-ever movement to be exclusively designed and produced inside the PRC. After 1971 the government made the 'Chinese Standard Movement'[73] (CSM 统一机芯 Tongyi Jixin, "Unified Movement"), the standard for mass production (in State Owned Enterprises, SOE, in China's Five Year Plan Economy) intended to replace the many different mechanical movements (Figure 20).

Figure 20: Left. Chuli (锄犁 Plough) watch; Center. Dong Feng (东风 Eastern Wind) watch with ST5 movement with 19 Zuan (rubies) after 1965; Right. The Maoist watch (see text).

After studying the structure and technical parameters of over 140 watches made by Swiss, Japanese, German, French and Russian factories, 'Dong Feng' (东风 Eastern Wind) was made by the Tianjin Watch Factory between 1966-1973. One model had the Maoist slogan "Serve the People" (为人民服务 Wei renmin fuwu) printed on the lower half of its dial in red paint, but this Communist Party connection meant it quickly disappeared when export became a management target. 'Fang Zhen' (**防震**) on the bottom of the dial means 'Shock Proof.' Note that most dials don't show the 13:50 time position as in Western advertisements.

Figure 21: Sea Gull (**海**鸥 Hai'ou), watches: Left, green Seagull Automatic Chinese Military Watch with Luminous Numerals (D813.581) limited ed., and Center, a regular type; Right. A Shanghai Military Watch Diver 24 Jewels SS4 (movement). In 1968, the Central Military Commission requested the Shanghai Watch Factory to produce military watches in a batch production with 29 Jewels SS2 and 24 Jewels SS4 movements. Only 30,000 pieces of the Shanghai Watch 114 (SS2/SS4) were produced.

A few years later, in 1958 'the Sea-Gull Corp.' [74] was established in the city of Tianjin. Apart from the green army watch (Figure 21), more modern watches were designed called Seagull (**海**鸥 Hai'ou), in combination with the proud text 'Made in China' (**中国制造** Zhongguo Zhizao), later 'China Made' would compete with the western models (Figure 21). The Dalian (Peacock) stands for **大**连手表厂 Dalian shou biao chang wristwatch factory) in Liaoning province (辽宁省 Liaoning sheng) was opened in 1957, specifically for manufacturing watches based on the CSM (This calibre has 17 jewels, 21,600 vibrations/hour of the escapement, min. 40-hour power reserve, and a fault rate of +/- 30 seconds a day). The factory still exists, now known as 'Dalian Golden Knight Watch Company'. It is a SOE and part of the Tianjin Seagull Watch Group. It mainly produces quartz-powered watches and watches made with movements bought in from Switzerland and Japan. The current Dalian Corp., producing products such as Ducor and Sha-Ou, formed a joint venture with the Japanese Seiko group [76].

Figure 22: Watches of the brand Chunlei (**春蕾**, Spring Bud, but Budlet on early copies); right, with calender, from Shanghai (**上海**).

Many factories came into existence, and spread over almost all provinces, viz. Shanghai Clock & Watch Industry Company; Shanghai Watch Factory; Shanghai No. 2 Watch Factory; Tianjin Clock & Watch Factory; Beijing, Liaoning, Guangzhou & Xi'an Hongqi Watch Factories; Xi'an Fenglei Meters & Watch Company; together with the Clock & Watch Research Institute of the Ministry of Light Industry in Xi'an, and the technicians and scholars of Timing Instruments of Tianjin University (Figure 22).

Originally, not only is the production Chinese but also the appearance: the name and numerals are in Chinese characters or depicted in Zodiac signs. For international customers, however, English (for Instructions for Use, **指示** Zhishi) and Arabic numerals are preferred to ensure success abroad (Figure 23). China's first industrial-scale clock-making factory, 'Yantai Polaris Timepiece Factory', opened in 1915. The 'Shanghai Watch Company' had watches with Hanzi characters. These and other products can be seen in the Alberta Museum of Chinese horology in Peace River AMCH/PR, USA (**艾伯塔中国**钟表博物馆/**加拿大艾伯塔省和平河** Aibota zhongguo zhongbiao bowuguan/jianada ai bo ta sheng heping he) or on its website [76]. The production was mainly for PRC home customers although some were exported. Most of the factories, and their early products have been lost over time due to China's huge reforms, and fast innovative processes.

Figure 23: Left, Clock with Hanzi (汉字) characters; Center, Quartz watch with 'earthly branches' dial, and Chinese numerals. Named after comrade Lech Walesa (**莱赫·瓦文**萨 Lai he·wa wen sa) the Polish reformer; Right, modern wrist watch with Chinese numerals (A-581 and A611 style watches).

End of the 19th - early 20th century

It was the watch-maker L. Vrard & Co. who started a shop with the name Hengdali (**亨達利**, lit. 'Frequently growing success') in Tianjin (1862), and later Shanghai (1864), Hankou (1889), soon Hong Kong and Beijing followed. He sold French and Swiss clocks for the Chinese market, often with Chinese style additions (Figure 24). Note that the "Hengdeli" **亨得利** Group (Int. Retail and Manufacturing) is not the same.

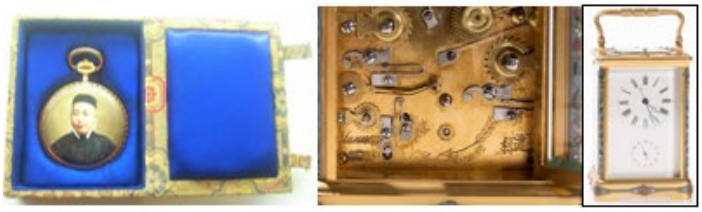

Figure 24: Pocket-watch with Chinese male on miniature in enamel, Tientsin/ Tianjin, L. Vrard & Co. c. 1900 (left); carriage clock with 'Hengdali' **亨達利** in Chinese characters on the mechanism (center and right).

After the 1970s: The Question of Authenticity and the Future

In the western world, many products in industry are the result of many years of Research and Development (**研究与开**发 Yanjiu yu kaifa). As a consequence, these products and their registered patents must be protected by law against competition and copying, e.g., the protection of 'intellectual property rights' (**知**识产权 Zhishi chanquan). In this respect, we must note the experienced superiority of the western world i.e., a colonial attitude, the accent on trade and profit, alongside the negative view on the copy-mentality of China.

Nowadays, in the international watch-market with many brand names, China has created a place for itself by modernizing and beginning a production for an international market with a full range of products but also with half-products. A typical aspect of Chinese trade is the replica and counterfeit watches of almost all international brands, especially the more expensive classic products such as Brequet, Vacheron, and more modern ones such as Breitling, Rolex, Hublot, Cartier, Omega, Mont Blanc, and Garmin. Today, Chinese products are also on offer on the western salerooms in China alongside genuine products [77]. Recently, the tourbillon has been copied, and although its complexity has been increased with double-tourbillons (after Grubel Forsey), such as the Patek Philippe Sky Moon Tourbillon 6002G, the Jaeger-LeCoultre Gyrotourbillon-3, or the Breguet Classique Tourbillon Extra-Plat 5377, its overall exclusivity has quickly eroded. William (Wai Lam) Shum of Hong Kong based 'Memorigin' (**萬希泉** Wan Xiquan, lit. Million Hope Spring) watchmakers said: 'Producers of High-end Chinese-made watches should invest in research and development to make more sophisticated mechanical functions, besides, independent watch-maker Qin Gan (**秦干**) stated when he redesigned the classic Longines 30L, that perfection is essential. At the same time, to meet the high demand of China's domestic market, China-made watches will continue using historic characteristics (e.g., Zodiac and Dragon series) to design different collections a high collectability value or 'auspicious blessings' (**吉祥的祝福** Jixiang de zhufu) to attract customers (Figure 25). The first cheap Chinese tourbillons Aatos Tiago Tourbilllon and Akribos XXIV were produced around 2013. This set the clocks for Harmony (**和**谐 Hexie): the smooth transition to post-Marxist ideology and capitalism à la Deng Xiaoping (邓小平 1904-1979) in the 'Made in China 2025' (**中国制造** 2025 Zhongguo zhizao erling'erwu) plan [78]. 'Innovation,' president Xi Jingping (1953-习近平) said, 'is of utmost importance, driven by - indeed money, but also tradition and socialist values.' Although the watch industry was not explicitly mentioned, the same rules apply [79].

Figure 25: Memorigin (**萬希泉** Wan Xiquan, lit. Million Hope Spring) watch with the Chinese Dragon and Phoenix $66,80000 (l), and Forsining, modern Chinese watch, with tourbillon and automatic winding, in tonneau or barrel-shaped form ca. 30 US$ sic! (c), Parmigiani (Kalpa, from Fleurier, Switzerland) in rosé gold ca. 30.000 US$ (r).

Conclusions

In three episodes the development of designing, production and marketing of clocks and watches is outlined. a. the first episode covers the first ancient clock-works in China, and confrontation with modern western time-measurement mathematics and clocks, b. the second episode of the opening-up of China under pressure of the international powers, and last, c. the third episode of the 'in-China' production of watches, both of original Chinese brands, with a short legacy yet, and the manufacture of copied/fake western watches. Every episode is marked by an exploration of foreign markets, and mastering technology as a tool to win more and more the People of China. In the meantime, China has developed from an isolated country to a global player with over 650 million watches produced in 2012.

Figure 26: Still-life Painting (静物画 Jingwu hua) by Pieter Claesz Heda (1594-c. 1680 彼得·克拉斯·赫达 Bi de. ke la si. heda), Museum Mauritshuis, The Hague (毛瑞特斯人 Mao rui te si ren), 1629; detail of the pocket watch in the left lower corner, as an example of Memento Mori sentiment.

The country's industry has produced a range of wonderful artistic technological time-pieces over a long period of time. The reader has met many great individuals, families, and cooperations with top craftmanship as well as high-ranking entrepreneurial abilities who have worked together efficiently in local workshops or grown into international businesses, with multi-dollar revenues, different in the Western world with its individuality principle, than in the Asian sphere with 'group-first' mentality. The practical issue of measuring time is now a fully accepted aspect standard of the international societies –not only to remember the End-of-Life (Memento Mori, 纪念品 Jinianpin, Figure 26), but to set the clocks for Harmony (和谐 Hexie) among the nations.

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