The Stars in their Eyes: Materials for Making Time in the Qing Empire, 1700-1900

by

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Dedication

To my spouse,
with all my love

Acknowledgements

Writing a history dissertation can be a lonely experience: countless hours spent peering over documents, tracking down information hidden in footnotes, and weaving sources into the threads of an argument. But that does not mean we do it alone. I owe a great deal to the many people who have supported my project over the past few years.

First and foremost, I must thank my committee members for without them my dissertation would not have happened. I could not have asked for a better mentor than my dissertation chair Yi-Li Wu who has constantly challenged me to investigate my sources more deeply and demonstrated the passion of a dedicated educator. I also thank Pär Cassel and Henry Cowles who have been wonderful advisors. Pär encouraged me to learn Mongolian, and I treasure the memories reading sources together in the Buddhist Studies Library. Always ready to brainstorm, Henry listened to my ramblings about epistemology and pushed me to think about new perspectives. I especially thank Sarah Schechner and Silvia Lindtner who joined the committee. Sarah has been an incredible fount of wisdom in teaching me how to think about objects and instruments. Silvia too has given her time to help me think about the broader implications of my arguments.

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I especially wish to acknowledge the library resources that made my project possible. The University of Michigan Library and the Interlibrary Loan staff have been incredible partners securing my hundreds of requests and allowing me to access rare materials. With our library's subscriptions and databases, I have been able to view archival documents from other repositories, including the First Historical Archives, the National Palace Museum in Taipei, and Academia Sinica. Moreover, I have benefitted from the millions of documents and materials that have

become increasingly available for collections in China and the rest of the world on HathiTrust, Gallica, Wikimedia, Chinese Text Project, Europeana, Library of Congress, CrossText Project, and more.

Finally, I wish to mention the many family members and friends who have helped me along the way. I could not have made it to where I am today without their support. I am grateful to my friends from Korea, who first pushed me to take the steps to apply for the doctorate, and to the many friends, both old and new, who have endured hearing about my struggles with Chinese clocks. I thank you all for your care and encouragement. And the person to whom I owe the greatest gratitude is my spouse Israel Shriki. Since we first talked about my dream to return to graduate school and complete my doctorate on top of the hill in Ramat Gan, he has been my greatest champion and supporter. He has sacrificed so much to move here and help me finish this project. Without him, I could not have done it. Thank you.

Preface

Reign Dates

In reporting dates, I have made choices for consistency and readability. First, although there are many ways to report imperial dates in Chinese, I have followed the popular practice of abbreviating dates in line with the imperial regnal title followed by the regnal year, month, and day. Thus, for a date in Kangxi 25 on the first day of the fourth month, I have abbreviated the date as **KX 25.4.1**. I follow this practice for any archival document that contains a date, as well as documents included in publications such as the *Veritable Records*.

I have tried to balance imperial dates with Gregorian dates. For a dissertation about time and integrating Chinese timekeeping into broader historiography, I initially wrestled whether to be more disruptive with dates. But I decided to emphasize readability and access. I therefore provide Western dates for biographical information and common events. When I discuss imperial dates and Chinese dating systems, I provide both imperial dates with an equivalent date in the Gregorian calendar system. For date conversion, I have employed Academia Sinica's Sinocal (https://sinocal.sinica.edu.tw/) to identify years with stems and branches. If necessary, I have used this algorithm for identifying a specific Gregorian date. In writing, I try to distinguish the systems by using terms such as "fourth lunar month" to signal the Chinese calendar rather than the Gregorian calendar.

Thirdly, I have followed a particular convention when reporting the dates of calendars. Because of the difficulty in knowing some of the exact dates of publication for every text, I have chosen to use printed dates. When reporting the year of a calendar date, I have always used the date printed on the front of the calendar or the last date of the calendar's compilation. Most calendars, of course, were published before their printed date. Hence, a calendar for Qianlong 35 was prepared and published in Qianlong 34. To be precise, one would need to state the publication as Qianlong 34. But as discussed in my dissertation, some calendars were not yet completed by the actual date and thus were also completed in the year when they said they were published. To simplify such concerns and ensure consistency for cases when it is difficult to know with more

precision, I always cite the printed date on the front of the calendar as the date of the calendar itself. If there is an issue about the actual publication date in the text related to issues of distribution and printing, I explain that issue in context rather than providing multiple dates for every publication. This convention also follows bibliographic practice with calendars to simplify the reporting of the information. Although some libraries are more consistent with the fact that an official calendar was usually prepared the year before the date on its cover, bibliographic entries for calendars typically record the date on the cover as the "publication date" regardless of whether calendars were prepared in advance.

Ming (1368-1644)

Reign Period	*Years*
Hongwu (HW)	1368-1398
Jianwen (JW)	1399-1402
Yongle (YL)	1403-1424
Hongxi (HX)	1424-1425
Xuande (XD)	1426-1435
Zhengtong (ZT)	1436-1449
Jingtai (JT)	1450-1456
Tianshun (TS)	1457-1464
Chenghua (CH)	1465-1487
Hongzhi (HZ)	1488-1505
Zhengde (ZD)	1506-1521
Jiajing (JJ)	1522-1566
Longqing (LQ)	1567-1572
Wanli (WL)	1573-1620
Taichang (TC)	1620-1620
Tianqi (TQ)	1621-1627
Chongzhen (CZ)	1628-1644

Qing (1644-1912)

Reign Period	*Years*
Shunzhi (SZ)	1644-1661
Kangxi (KX)	1662-1722
Yongzheng (YZ)	1723-1735
Qianlong (QL)	1736-1795
Jiaqing (JQ)	1796-1820
Daoguang (DG)	1821-1850
Xianfeng (XF)	1851-1861
Tongzhi (TZ)	1862-1874
Guangxu (GX)	1875-1907
Xuantong (XT)	1908-1912

Personal Names

One of the challenges in working with names in different languages is the different naming conventions for ordering names. Throughout the dissertation, I have tried to follow the naming practice in reference to the language of publication. For publications in Western languages, I have followed the general convention of using Firstname Surname. For publications in East Asian languages, I have followed the convention in East Asia of Surname Firstname. I have used this for both primary and secondary sources when the sources are published in Chinese. Furthermore, I have also followed the preferred source of characters for one's name depending on whether the person uses simplified or traditional characters. Thus, I have reported simplified characters for PRC publications and used traditional characters for Taiwanese and Hong Kong publications.

Transcriptions and Romanizations

For Chinese language sources, I have used the Pinyin romanization for names and terms. In the case of historical sources which may have used another system, such as Wade-Giles, I add a Pinyin transcription in brackets along with the original transliteration to report the source with an annotation (e.g. ching-shih [jingshi]). For Manchu sources, I have used the Möllendorf romanization. For Mongolian sources, I have used Christopher Atwood's updated romanization.

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Abstract

This dissertation argues that public time in the Qing dynasty (1644-1912) was a material infrastructure whose credibility depended on continual maintenance. Historians typically locate China's shift to modern temporality within late-nineteenth-century industrialization, treaty ports, and Western technologies. This project complicates that narrative by uncovering a longer history of change driven by internal Qing infrastructural reforms. Combining material culture with archival documents, state records, private writing, technical handbooks, and biographical narratives, the dissertation explores how different users produced the instruments used for telling time and how these actors transformed these tools for their own needs.

Each chapter uses material analysis to examine the shifting relations between the state, society, and an emerging class of temporal practitioners. Chapter one investigates calendars as a manufactured object through its layout and design, its vernacular history of publishing, its empire-wide distribution networks, and its use as both a scheduling device for rituals and a writing surface for inscription. Chapter two documents the turning point in the market for time as almanac makers commercialized temporality with almanacs and their own instruments and created a transformation in the social and cultural values of time. Chapter three focuses on Zhang Zuonan's emerging school of statecraft and practical governance which was premised on his newly designed mathematical and astronomical instruments that pioneered *ritual precision* so that local gentry might engage in public administration. Chapter four uses clocks, manuals, memorials, and biographical information to reveal how Chinese clockmakers tried to present new theories of time for Chinese audiences and how they created new forms of clocks to model temporality.

The dissertation makes three major contributions to the field. First, this research provides the first book-length, English-language study on Chinese scientific instruments by offering a new approach to understand how scientific knowledge changed outside the Western world. Second, by distinguishing between the rise of labor time from the broader commodification of time (such as in clocks and almanacs), the dissertation identifies how entrepreneurs and intermediaries solved practical problems for knowing time and filled in the gaps in the state's temporal infrastructure.

Finally, the dissertation introduces the concept of *ritual precision* as a model for understanding the cultural values for defining precision and governance as well as a critical analytic for how late imperial scholars connected science, technology, and culture.

Introduction

One evening on the 3rd day of the 5th month in the 25th year of the Jiaqing reign (1820), Assistant Brigade Commander Li Tianyuan 李天元 hired a local acting troupe. At the time, he was stationed in Suide 綏德 Prefecture, in northeastern Shaanxi 陝西 Province. Li was hosting a feast for the God of the Soil (i.e. *tushen* 土神) and paid for an opera performance as a part of the celebration. The following day, An Yuqing 安玉青, a foot soldiers in the garrison, complained about Li to the commander Zheng Kaitai 鄭開泰, a military official from Zhejiang province and who had passed the military *jinshi* 進士 exam. Soldier An claimed that Assistant Brigade Commander Li had violated a ritual rule governing schedules in late imperial China: he had conducted ceremonies on an imperial death anniversary day, a *jichen* 忌辰 day in the state calendar, which was forbidden by law.[1]

Soldier An could complain about such an issue of scheduling because calendars were ubiquitous in everyday life in Qing China. Foot soldiers, commanders, government officials, and even common folk from small villages all had access to state calendars that provided information for planning and carrying out tasks. State calendars were booklets with general information about the year and detailed tables of months and days (see Figure Intro-1). They came in different sizes, some resembled ordinary books, while others were closer to folded brochures that could be stored in a pocket. The government sponsored their production because the state wanted this information to be publicly available, and, in theory, to enable empire-wide coordination. Like today's calendars, official Qing calendars told readers the length of each month and the dates of celebrations and holidays. But they were more than lists. They also reported all kinds of information related to

[1] Board of Punishments, "230887," Communication 移會, JQ 25/2, Grand Secretariat Neige daku dang'an.; Richard J. Smith, *Fortune-Tellers and Philosophers: Divination in Traditional Chinese Society* (Westview Press, 1991). 80. For a detailed analysis on historical naming, see Piotr Adamek, *A Good Son Is Sad If He Hears the Name of His Father: The Tabooing of Names in China as a Way of Implementing Social Values* (Routledge, 2017)., esp. 42-44

planning and scheduling, including when to travel, when to build, and even when to bathe.[2] Calendars were designed as integrated tables. Readers moved their fingers across the tables like columns and rows in a spreadsheet. They scanned headings for dates and checked the rows beneath to examine to determine its auspiciousness.

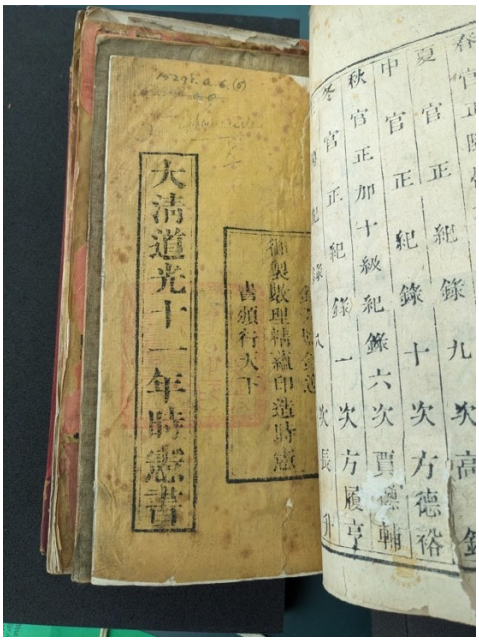

Figure Intro-1: Image of Bound Calendars. This book from the British Library contains a set of bound calendars. They come in different sizes and shapes as visible in the outline of the three different examples here. Source: Author Image

Since the government was responsible for printing these booklets and making them available for the general populace, the dispute between Li Tianyuan and An Yuqing should have been easy to resolve. One needed only to open the calendar to the month and day in question and check whether the date coincided with an imperial death anniversary. If it did, then Li had indeed committed a crime. In theory, calendars were standardized, at least in terms of their dates and scheduling information. Each person's calendar should have contained the same information. In practice, however, the matter was never so simple.

At first, Commander Zheng investigated the affair. He checked his own documents and determined that Li had committed an error on the 3rd day of the month. He confiscated the opera

[2] Smith, *Fortune-Tellers and Philosophers*. 81-83; Richard J. Smith, "'Knowing Fate': Divination in Late Imperial China," *Journal of Chinese Studies* 3, no. 2 (1986): 172-173.

equipment from the commissioned troupe and fined Li for the violation. Later as a part of Li's deposition, Li stated that he was worried about additional punishment from Commander Zheng. So, Li paid the fine and additional money to the military official. But when Li opened his own calendar again some days later, he saw that the imperial taboo day was listed under the 2nd, not the 3rd day. He had followed the calendar correctly. At that moment, he believed that Soldier An and Commander Zheng had collaborated to extort money from him. He therefore decided to file a formal complaint first against Zheng as a corrupt official, and then against An Yuqing for making false reports.

The corruption charges escalated what had initially been a simple matter of fines. The case now moved up the administrative ladder and involved higher authorities. Deputies arrived at the garrison to collect more evidence. At the same time, An Yuqing filed a countersuit against Li. Soldier An claimed Li was making false reports. He submitted his own state calendar to substantiate his case, and his calendar refuted Li's evidence. The 3rd day of the month was a taboo day. He had not made any false claims but simply relied on his state calendar. [3]

If both parties submitted the evidence from their copies of calendars for their lawsuits, why did the two calendars differ concerning such important information? State calendars were supposed to be reliable documents because they standardized schedules and time-finding. During compilation, the government required department managers to submit copies for authorization. For garrisons and government offices outside the capital, the government sent models to local offices which then contracted printing local printers and used the state seal to authenticate the finished calendars as official documents. All throughout, officials had to ensure that no one tried to produce calendars that threatened the legitimacy and power of the state. Calendars based on alternative systems of reckoning or concepts of time could be so threatening, that in the most extreme cases such as the White Lotus revolts, perpetrators could be punished as traitors.

The governor-general Changling 長齡 (1758-1838) investigated the situation more thoroughly. He found that both individuals had told the truth about their printed calendars. The discrepancy came from the printing networks. The district magistrates had contracted the production of calendars to multiple artisans in several areas around the county seat. One carver had made a mistake while cutting the woodblocks, introducing the error that had generated the

[3] Board of Punishments, "230887."

misprint. Both An and Li had read their calendars accurately, but Li's calendar was wrong. It did not represent the official calendar created by the Imperial Astronomical Bureau.[4]

This case exposes much more than misprints and mistakes. It highlights that official time depended on a chain of material practices: calculation, copying, carving, printing, sealing, distribution, reading, and trust. Consequently, this incident raises two concerns that have broader implications for understanding time and its consequences in late imperial China. First, the case that centered on the materiality of instruments. As An and Li disputed what kind of day it was, they relied on the physical calendars at hand, not an abstract debate over calendar systems and theories. This point is counterintuitive, because calendars disputes have often been regarded as social and cultural conflicts, rather than material ones. Classic examples include debates over the Julian and Gregorian calendars, resistance to the calendar of the French Revolution, and political debates over standardizing times.[5] Historians of China have equally written about the changes in calendar systems over time and the disputes between different communities over standards.[6] Yet An and Li both possessed calendars, and both trusted their calendars because they were official, sealed documents. Both men recognized imperial taboo days. They were not debating whether one calendar system was better or more efficient. What mattered was that their sources of information diverged.

In this dispute, the materials for making the calendar mattered. Knowing the time was a complex problem. It required shared standards and agreements, and people employed tools to simplify that problem. When these tools were not properly coordinated, different understandings

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[4] Board of Punishments, "230887."

[5] Eviatar Zerubavel, "The French Republican Calendar: A Case Study in the Sociology of Time," *American Sociological Review* 42, no. 6 (1977): 868–77.; Eviatar Zerubavel, *Hidden Rhythms: Schedules and Calendars in Social Life* (University of California Press, 1985), esp. 98-100; Ian Bartky, "The Adoption of Standard Time," *Technology and Culture* 30, no. 1 (1989): 25–56.; Robert Poole, "'Give Us Our Eleven Days!': Calendar Reform in Eighteenth-Century England," *Past & Present* 149, no. 1 (1995): 95–139.; Ian Bartky, *One Time Fits All: The Campaigns for Global Uniformity* (Stanford University Press, 2007).; On Barak, *On Time: Technology and Temporality in Modern Egypt* (University of California Press, 2013). 115-144; Vanessa Ogle, "Whose Time Is It? The Pluralization of Time and the Global Condition, 1870s—1940s," *The American Historical Review* 118, no. 5 (2013): 1376–402.; Vanessa Ogle, *The Global Transformation of Time, 1870–1950* (Harvard University Press, 2015).

[6] Christopher Cullen, *Heavenly Numbers: Astronomy and Authority in Early Imperial China* (Oxford University Press, 2017); Daniel Patrick Morgan, *Astral Science in Early Imperial China: Observation, Sagehood, and the Individual* (Cambridge University Press, 2017).; Elizabeth Vander Ven, "It's Time for School: The Introduction of the New Calendar in Haicheng County Primary Schools, Northeast China, 1905-1919," *Twentieth-Century China* 32, no. 2 (2007): 60–83; Henrietta Harrison, *The Making of the Republican Citizen: Political Ceremonies and Symbols in China, 1911-1929* (Oxford University Press, 2000), 66-71.; Wang Erh-min, *Ming Qing Shi Dai Shu Min Wen Hua Sheng Huo* 明清時代庶民文化生活 (Yuelu shu she, 2002), 25-33.

about time produced confusion over what counted as the standard. In the case of An and Li, the content and layout of the calendar were not the same. Calendars that were supposed to be copies of state models functioned instead like individual artifacts. Calendars were ephemeral and formulaic documents, yet they also had individual lives.[7] They were manufactured objects. Li and An read their calendars as individual books. The documents were representatives of the state and had social significance. At the same time, they were deeply personal objects that people scanned, marked, consumed, and read. As people made decisions and planned, they trusted that these calendars would allow broader coordination in time. In other words, materiality both shaped and informed how people perceived and evaluated time.[8]

Second, although this disagreement began with An and Li, it raised new questions about the broader system that enabled people to know the time. Who was involved in the process? How had these soldiers acquired their calendars? These questions reveal an entangled network of actors who had frequently escaped attention, including government officials, clerks, printers, carvers, and the suppliers. Individuals were just one part of the problem. A further investigation had to examine what kinds of technologies were being used by these actors and how had the organization of these technologies impacted this outcome? This was a problem of logistics, communication networks, and coordination. Calendars, after all, were printed artifacts, embedded within late imperial print culture. They shared a basis in far-reaching social and economic systems. Even though the government treated calendar distribution and the public sharing of time as a seamless connection between state and society, calendars depended on much more: astronomers; scribes; suppliers; carvers; printers; distributors; bookshops; and then readers.[9]

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[7] For the concept of the social and biographical approach to objects, see Arjun Appadurai, "Introduction: Commodities and the Politics of Value," in *The Social Life of Things: Commodities in Cultural Perspective*, ed. Arjun Appadurai (Cambridge University Press, 1986).; Igor Kopytoff, "The Cultural Biography of Things: Commoditization as Process," in *The Social Life of Things: Commodities in Cultural Perspective*, ed. Arjun Appadurai (Cambridge University Press, 1986).

[8] Compare with Kevin Birth, *Objects of Time: How Things Shape Temporality* (Palgrave Macmillan, 2012).; Gianenrico Bernasconi and Susanne Thürigen, eds., *Material Histories of Time: Objects and Practices, 14th to 19th Centuries* (De Gruyter, 2020).

[9] My approach to materiality is influenced by earlier research that has viewed the material history of the book as the foundation for understanding the "communications circuit" and the "communications networks" that enabled information to flow. Robert Darnton, "What Is the History of Books?," *Daedalus* 111, no. 3 (1982): 65–83.; Thomas R. Adams and Nicolas Barker, "A New Model for the Study of the Book," in *A Potencie of Life: Books in Society, The Clark Lectures, 1986-1987*, ed. Nicolas Barker (British Library and Oak Knoll Press, 1993). Nevertheless, the history of the book in China does not easily align to these models. Emily Mokros, Joseph Dennis, and Devin Fitzgerald, for example, have all critiqued aspects of this history including the troubling ways in which woodblocks

This dissertation argues that public time in the Qing dynasty was a material infrastructure—composed of artifacts, labor, and distribution networks—whose credibility depended on continual maintenance and monitoring. The 1820 Suide garrison case shows that calendrical authority was not only a matter of abstract temporal theory but of media systems that made time actionable: the production, authentication, circulation, and use of specific objects. Over the eighteenth and nineteenth centuries, the governance of this infrastructure shifted as officials increasingly relied on commercial printers and other intermediaries. These changes introduced new frictions and new incentives to modify and redesign time-knowledge. By tracing calendars, almanacs, mathematical and astronomical instruments, and mechanical clocks, I show how these material frictions reconfigured relations among officials, artisans, merchants, and users and how those actors reshaped practices of temporality.

This network of dependence only intensified with time. Although the authorities had initially relied on government printers, the rising demand for information led the Qing to allow more commercial printers to become involved. This shift generated unintended consequences by reconfiguring the relationship between the state and lower levels of society. Whereas the previous model had emphasized a state monopoly on information, the introduction of private merchants created new incentives to alter, transform, and redesign these artifacts for consumers.[10] This

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can be recycled. Most recently, Mokros has argued in favor of a branching model to understand the movement of texts across editions and space. Joseph Dennis, *Writing, Publishing, and Reading Local Gazetteers in Imperial China, 1100-1700* (Harvard University Asia Center, 2015). 4-5; Devin Fitzgerald and Carla Nappi, "Information in Early Modern East Asia," in *Information: A Historical Companion*, ed. Ann Blair et al. (Princeton University Press, 2021).; Emily Mokros, "Chinese Gazettes on the Margins of Book History: Movable Type, Wax Stereotypes, and Vernacular Techniques in Late Imperial China," *Book History* 26, no. 1 (2023): 164–202. However, by introducing the notion of infrastructure and logistics, or the material aspects of information networks, I suggest that branching should also reflect the broader roots and trunk or rivers and streams that structured this network. I treat networks as requiring different scales and layers to understand how this information flows and moves. See also Anna L. Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton University Press, 2021). 138-139

[10] The case of calendars reflects trends in other state monopolies. Although there are important moments of change, such as the introduction of the *lijin* tax to raise funds in the wake of the Taiping Rebellion, William Rowe argues in favor of the salt and tea monopolies as undergoing this form of privatization. William T. Rowe, *Hankow: Commerce and Society in a Chinese City, 1796-1889* (Stanford University Press, 1984). 119-121. Susan Mann similarly claims that "liturgical governance" introduced local responsibility for grain merchants and tax intermediaries to increase private management. Susan Mann, *Local Merchants and The Chinese Bureaucracy, 1750-1950* (Stanford University Press, 1987). 12-28. Helen Dunstan, on the other hand, takes a more circumscribed approach to commercialization and privatization in the eighteenth and nineteenth centuries, distinguishing between episodic moments of "liberalization" and the larger pattern of bureaucratic management. Helen Dunstan, "Safely Supping with the Devil: The Qing State and Its Merchant Suppliers of Copper," *Late Imperial China* 13, no. 2 (1992): 42–81.; Helen Dunstan, *State or Merchant?: Political Economy and Political Process in 1740s China* (Harvard University Asia

transformation affected not only state publications but also the larger infrastructure that made up the tools people used to access public information on time. With the relaxation of government restrictions on this market, entrepreneurs and popularizers developed other types of instruments to further disseminate this knowledge in broader and more radical ways.[11] As official policy recognized the need for private reforms, they introduced markets and commercial solutions that encouraged innovations and new approaches to calculating and learning time information. These markets and networks connected public and private infrastructures, fostering opportunities for new knowledge and competition with older forms of knowledge.

These networks can be framed as a form of public, material infrastructure.[12] The Qing dynasty, like its predecessors, viewed the public distribution of time as a government responsibility. For time to coordinate society, it required shared standards. The dissemination of time information was therefore an official duty. It was institutionalized through annual rituals and defined good,

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Center, 2006). 139-146. For a recent overview on the *lijin* tax and state-merchant relations, see Shengyu Yang, "Business Magnates, Public Philanthropists, and Art Connoisseurs: Suzhou Gentry and the Nationalization of Lijin in Qing China" (Phd Dissertation, Princeton University, 2023).

[11] This idea builds on the significance for popular entertainment in theater and drama as a mode for disseminating knowledge. Susan Naquin and Evelyn S. Rawski, *Chinese Society in the Eighteenth Century* (Yale University Press, 1987). 59; Andrew Schonebaum, *Novel Medicine: Healing, Literature, and Popular Knowledge in Early Modern China* (University of Washington Press, 2016). 73-121. There were a variety of precedents for this model already in effect since the late Ming. Joanna F. Handlin, *Action in Late Ming Thought: The Reorientation of Lü K'un and Other Scholar-Officials* (University of California Press, 1983). 143-160; Victor H. Mair, "Language and Ideology in the Written Popularizations of the Sacred Edict," in *Popular Culture in Late Imperial China*, ed. David Johnson et al. (University of California Press, 1985).; Andrea Breard, "On the Transmission of Mathematical Knowledge in Versified Form in China," in *Scientific Sources and Teaching Contexts Throughout History: Problems and Perspectives*, ed. Alain Bernard and Christine Proust (Springer Dordrecht, 2014).

[12] The field of science and technology studies (STS) has impacted my use of "material infrastructures". In the *Promise of Infrastructure*, the authors introduce material infrastructures as an analytic to explore not just how infrastructures put circulation in space, but also how this stuff defines access, control, and the politics of resistance. "Material infrastructures, including roads and water pipes, electricity lines and ports, oil pipelines and sewage systems, are dense social, material, aesthetic, and political formations that are critical both to differentiated experiences of everyday life and to expectations of the future." Hannah Appel et al., "Introduction: Temporality, Politics, and the Promise of Infrastructure," in *The Promise of Infrastructure*, ed. Nikhil Anand et al. (Duke University Press, 2018). 3. The concept of material infrastructures situates this network in time and space. Material infrastructures are made up of people, choices, and the technologies that situate these actions. It highlights standards and categories and the consequences of these standards on organizing life. Although infrastructures have frequently been treated as sites that construct experiences of space and time, the history of time networks has received less specific attention. For additional context on material infrastructures, see Geoffrey C. Bowker and Susan L. Starr, "Introduction: To Classify Is Human," in *Sorting Things Out: Classification and Its Consequences*, ed. Geoffrey C. Bowker and Susan L. Starr (MIT Press, 1999). 6-10; Paul Edwards, "Infrastructure and Modernity: Force, Time, and Social Organization in the History of Sociotechnical Systems," in *Modernity and Technology*, ed. Andrew Feenberg et al. (MIT Press, 2003).; Penelope Harvey, "Cementing Relations: The Materiality of Roads and Public Spaces in Provincial Peru," *Social Analysis* 54, no. 2 (2010): 28–46.; Brian Larkin, "The Politics and Poetics of Infrastructure," *Annual Review of Anthropology* 42 (2013): 327–43.; Tsing, *The Mushroom at the End of the World*.

stable, and legitimate government. Time was a fundamental structure that enabled social and cultural exchange. Just as the government secured the flow of money and maintained roads and bridges, it also managed the public dissemination of time. This infrastructure required maintenance and management. It was composed of diverse technologies and individuals, and it had specific material forms that changed over time.

Print and manuscript calendars represented an important part of this infrastructure, but they were just one source of information. The materials for telling time included paper tools, maps, astronomical objects, smells, chanting, shadows, bells, mechanical devices, and even bodily gestures.[13] What unites these time-telling devices is that they mediated knowledge. They had different functions and operations depending on the context. These materials also changed over time. As officials debated how strong the state should be, markets offered alternatives for finding time and created opportunities for transforming tools with innovations. The materials for making time traced a shift in the practices used to connect individuals to the state. Each tool proffered a distinct attitude about time, and it required new approaches for integrating, inferring, and building broader commensurate systems. These were interconnected forms of measurement and time.

How, then, did the case between Li and An conclude? The government punished nearly everyone involved. The military official Zheng Kaitai was found guilty of extortion. An Yuqing, despite the veracity of his own calendar, was punished for making a false report and stirring up trouble. The intermediaries who had helped carry the money between Li and Zheng were punished for having accepted fees as go-betweens. Li may not have intended to violate the taboo, but he was still cashiered for what he had done. The government also pursued the carvers and the calendars themselves. Individual carvers were to be hunted down and punished for having produced the mistakes that had caused the entire affair in the first place, and the calendars which had been made with the faulty woodblocks had to be rounded up and confiscated.[14]

[13] These objects all served various cognitive and useful functions to simplify the communication and identification for time. They were all tools in particular contexts. It is this embedded and situated context that informs my approach for treating these instruments as the mediation of time. I consequently trace these connections in a similar movement to the movement of science from the laboratory to the public and back. Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Harvard University Press, 1987). For a similar material first approach, see James Poskett, *Materials of the Mind: Phrenology, Race, and the Global History of Science, 1815-1920* (University of Chicago Press, 2019).

[14] Board of Punishments, *"*230887.*"*

By 1820, the government system for circulating time information was changing. Private actors were involved in producing the state time networks, and the very information used to produce this knowledge was increasingly vulnerable to error, alteration, and commercial incentives. New producers and consumers were changing how people agreed on what mattered in terms of time and which sources of time information could be trusted. The calendar misprint case demonstrated what could happen when this system broke down. Furthermore, it revealed the complexity behind public time. The government struggled to manage a system across vast distances and to coordinate local sites into a single imperial network.

How then did instruments impact late imperial China? In starting from these instruments and tools, this dissertation traces the material practices that formed the Qing infrastructure in time and how these networks and institutions changed through the eighteenth and nineteenth centuries. By drawing on material artifacts that included calendar ephemera and scientific instruments as well as the various sources that help explain them (e.g. archival records, technical manuals, scholar notes), I demonstrate that different communities combined tools to construct new practices of temporality. These material objects both reflected the role of the state in managing society and how individuals could alter this infrastructure. As new technologies entered this network, some figures resisted the tools where others led to change. Time technologies empowered artisans and local makers, and they promoted thinking in terms of local and global relationships.

From misprints to new instruments, the chapters that follow argue that public time in the Qing was produced through material infrastructures which depended on printing, authentication, circulation, repair, and use. This object-first approach draws attention away from treating calendars and clocks primarily as symbols of political legitimacy or as indices of modernization. It repositions them toward the practical problems of how temporal knowledge became trustworthy and actionable across distances. In shifting focus, my dissertation intervenes within several strands of historical scholarship, namely work on ritual and authority, instruments and technology, and intersection of temporality and modernity. My work identifies how an object-centered, infrastructural approach revises these assumptions and introduces the co-production of temporality.

1.1 Historiography

Material Time

The material approach to time offers a new methodology to study the change in cultures of time in late imperial and modern China. This is not to say that scholars of the Qing (1644-1912) and the long Republic (1890-1949) have ignored clocks and calendars. On the contrary, the field has produced a range of different studies on these instruments and their contexts. But historians and anthropologists have typically focused on these instruments as concepts rather than as physical objects. Furthermore, scholars have typically placed these instruments within larger debates concerning cultural integration and modernization. In trying to explore the impact of culture on social organization, these questions have laid an important groundwork for understanding culture and time in imperial and modern China. By foregrounding artifacts and their circulation, I ask not only what time meant, but how time-knowledge was made reliable, and what happened when it was not. Frictions over material infrastructures provided opportunities for intermediaries (e.g. printers, carvers, sellers, artisans) to impact political culture and define temporality.

Integration and Authority

For Chinese rulers, the public communication of time was a fundamental principle of political legitimacy. In classical political theory, the emperor helped connect the macrocosm of the universe with the broader polity. He was responsible for the promulgation of the seasons, and he had to be able to manage uncertainty. Anomalies, such as solar eclipses, comets, or other unexpected phenomena had to be carefully documented and predicted to ensure that the dynasty maintained the *Tianming* 天命 "Mandate of Heaven".[15] While the Mandate of Heaven was not the only model of authority in antiquity and has its own history as a political theory, it remained a shared ideal for many different groups in the late imperial period.[16] The concept had especial authority as well

[15] For additional context on this concept, see Frederic Wakeman, Jr., *The Fall of Imperial China* (The Free Press, 1975), 55-70.; Rafe de Crespigny, *Portents of Protest in the Later Han Dynasty: The Memorials of Hsiang K'ai to Emperor Huan* (Australian National University Press, 1976), 1-20.; David W. Pankenier, "The Cosmo-Political Background of Heaven's Mandate," *Early China* 20 (1995): 121–76.; Mark Elvin, "Who Was Responsible for the Weather? Moral Meteorology in Late Imperial China," *Osiris* 13 (1998): 213–37.; Sarah A. Queen and John S. Major, eds., *Luxuriant Gems of the Spring and Autumn: Attributed to Dong Zhongshu* (Columbia University Press, 2016).

[16] There were a variety of other myths that justified authority in ancient China as documented by Sarah Allen, *The Shape of the Turtle: Myth, Art, and Cosmos in Early China* (State University of New York Press, 1991).; David N. Keightley, *The Ancestral Landscape: Time, Space, and Community in Late Shang China (ca. 1200–1045 B.C.)* (University of California Press, 2000).; Sarah A. Queen, *From Chronicle to Canon: The Hermeneutics of the Spring and Autumn, According to Tung Chung-Shu* (Cambridge University Press, 1996). For the Qing, Thomas Metzger

because of its antiquity linked to the *Shangshu* 尚書 *Book of Documents*, where we find the classical myths of the Emperor Yao 堯 sending emissaries to different parts of the Central Plains to collect data that would establish the calendar.[17]

For scholars of China in the 1950s and the 1960s, the calendar was the most important mechanism by which the state exercised social control down to the village level and created cultural integration throughout the imperial territories and even spread its influence to the rest of the Sinosphere. Although the techniques of the calendars changed over time, these scholars emphasized that calendars had implications for governing local society. Calendars had public functions in creating community rituals of seasonal change as well as organizing public festivals and the celebration of state sacrifices. But they also had other, more subtle functions in the organization of village life because the knowledge system that was linked with calendars such as the use of fortune-telling and auspicious day selection created additional rhythms of a life cycle (e.g. birth, marriage, burial). These ideas were based on the technologies of time as well. Most individuals participated in these practices, since these technologies were optimized for the most important needs of people: family stability and economic advancement. While other aspects of orthodoxy, including the examination system, also shaped the mechanisms by which the state managed society, the system of communicating time, which encompassed the management of daily hours as well as the public distribution of calendars, formed an important technology or infrastructure that connected the authority of the state to the home.[18]

However, starting in the 1970s, a new generation of scholars turned toward the study of popular culture and challenged this top-down vision of authority. Local festivals and religious practices could vary tremendously across different regions and even between villages. Yet how could Ming and Qing China seem to be so culturally integrated at the same time, especially in comparison with contemporary Europe? How did local officials, community leaders, and common

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defined Qing political culture through the lens of Confucian and Legalist frameworks, whereas Pamela Crossley has referred to the multiple forms of political legitimacy through the idea of various constituencies. Thomas A. Metzger, *The Internal Organization of Ch'ing Bureaucracy: Legal, Normative, and Communication Aspects* (Harvard University Press, 1973).; Pamela K. Crossley, *A Translucent Mirror: History and Identity in Qing Imperial Ideology* (University of California Press, 2002). 44-45

[17] Bernhard Karlgren, *"*The Book of Documents,*"* *Bulletin of the Museum of Far Eastern Antiquities* 22 (1950): 1-8.

[18] Hsueh-yen Chang, *"*The Lunar Calendar as a Social Control Mechanism in Chinese Rural Life*"* (Phd Dissertation, Cornell University, 1940).; Kung-Chuan [Xiao Gongquan] Hsiao, *Rural China: Imperial Control in the Nineteenth Century* (University of Washington Press, 1960).; John K. Fairbank, *"*A Preliminary Framework,*"* in *The Chinese World Order: Traditional China's Foreign Relations*, ed. John K. Fairbank (Harvard University Press, 1968), 1-19.

people negotiate these different strands of authority?[19] Whereas some authors pointed to the significance of print media, drama, or even class identity, James Watson emphasized the coopting of local deities into the standardized ritual order. In Watson's study of the Tianhou cult, local elites collaborated with state officials to make local cults follow proper orthodox values of loyalty, although the state could rarely control beliefs outright.[20] In other words, while state authority created a shared set of rituals and symbols, the meaning attributed to these items remained open for interpretation and adaptation. On the other hand, Michael Szonyi and Prasenjit Duara suggested that historians needed to carefully examine the claims about standardization in contrast to the realities of actual practice. From this point of view, ritual was less a matter of conforming to state orthodoxy as a site for negotiation.[21]

This debate over ritual and authority – what has come to be called the standardization of the gods debate – has continued to inform how scholarship views instruments of time finding and time marking.[22] On the one hand, Mongols and Joseon Koreans were selective in how they chose to participate in imperial rituals.[23] Chinese Christians also adapted to multiple sets of temporal order creating their own special calendars for their private use.[24] Popular practices such as

[19] See essays in David Johnson et al., eds., *Popular Culture in Late Imperial China* (University of California Press, 1985).; James L. Watson and Evelyn S. Rawski, eds., *Death Ritual in Late Imperial and Modern China* (University of California Press, 1990).; Kwang-Ching Liu, ed., *Orthodoxy in Late Imperial China* (University of California Press, 1990).; Kwang-Ching Liu and Richard Hon-Chun Shek, eds., *Heterodoxy in Late Imperial China* (University of Hawai′i Press, 2004).

[20] James L. Watson, "Standardizing the Gods: The Promotion of T′ien Hou ('Empress of Heaven′) Along the South China Coast, 960-1960," in *Popular Culture in Late Imperial China*, ed. David Johnson et al. (University of California Press, 1985).

[21] Prasenjit Duara, "Superscribing Symbols: The Myth of Guandi, Chinese God of War," *Journal of Asian Studies* 47, no. 4 (1988): 778–95.; Michael Szonyi, "The Illusion of Standardizing the Gods: The Cult of the Five Emperors in Late Imperial China," *Journal of Asian Studies* 56, no. 1 (1997): 113–35.

[22] Donald S. Sutton, "Ritual, Cultural Standardization, and Orthopraxy in China: Reconsidering James L. Watson′s Ideas," *Modern China* 33, no. 1 (2007): 3–21; Michael Szonyi, "Making Claims about Standardization and Orthopraxy in Late Imperial China: Rituals and Cults in the Fuzhou Region in Light of Watson′s Theories," *Modern China* 33, no. 1 (2007): 47–71; James L. Watson, "Orthopraxy Revisited," *Modern China* 33, no. 1 (2007): 154–58; David W. Faure and Zhiwei Liu, "Standardization or Legitimization? Perception of the Unity of Chinese Culture from the Standpoint of Popular Beliefs," *Journal of History and Anthropology* 6, nos. 1–2 (2008): 1–21. ; Donald S. Sutton, "Cultural Unity, Variation and the State in Ming and Qing Times: A Contribution to the Debate on Standardization and Orthopraxy," *Journal of History and Anthropology* 7, no. 2 (2009): 139–63.

[23] JaHyun Kim Haboush, "Contesting Chinese Time, Nationalizing Temporal Space: Temporal Inscription in Late Choson Korea," in *Time, Temporality, and Imperial Transition: East Asia from Ming to Qing*, ed. Lynn A. Struve, (University of Hawaii Press, 2005), 115-141; Johan Elverskog, "Mongol Time Enters a Qing World," in *Time, Temporality, and Imperial Transition: East Asia from Ming to Qing*, ed. Lynn A. Struve, (University of Hawaii Press, 2005), 142-178.

[24] Eugenio Menegon, "The 'Teachings of the Lord of Heaven′ in Fujian: Between Two Worlds and Two Times," in *Time, Temporality, and Imperial Transition: East Asia from Ming to Qing*, ed. Lynn A. Struve (University of Hawaii Press, 2005).

"tracking the nines" existed outside of the state system yet connected daily life in the court with daily life in the field.[25] Private almanacs reflected state orthodoxy yet at the same time undermined it.[26] On the other hand, imperial policy allowed flexibility for local practices as long as they conformed to the general orthodoxy. For each new territory that was incorporated into the Qing, the state set up local centers of printing, distribution, and time signals to both allow community autonomy and integration into an external standard.[27] While the early Republic witnessed the development of local time zones, the making of the People's Republic of China again built an imperial standard that was used across the entire territory.[28]

Technology and Culture

The political study of time has also given rise to a related literature that has examined the cultural influence on the development of technology, particularly in the context of mechanical clocks. Lewis Mumford was one of the first historians to draw attention to the specific functions of clocks as agents of social and cultural change. He praised clocks over steam engines as the model industrial technology. Clocks rather than steam engines contained both automation and internal power. Clocks had the effect not only of removing the calculation of time from natural cycles into an abstraction but also of generating mathematical concepts of division and separation.[29] Mechanical clocks had associations with monasteries, but the rise of public clocks in the thirteenth and fourteenth centuries reflected the changing attitudes about time and the significance of new forms of temporal organization, or what Jacques le Goff contrasted as the cycle of religious

[25] Fu Lianzhong, "Jiu Jiu Xiao Han Tu 九九消寒圖," *Zi Jin Cheng*, no. 5 (1982): 31–32.; Maggie Bickford, "Three Rams and Three Friends: The Working Lives of Chinese Auspicious Motifs," *Asia Major* 12, no. 1 (1999): 127–58.
[26] Smith, "'Knowing Fate': Divination in Late Imperial China"; Richard J. Smith, "A Note on Qing Dynasty Calendars," *Late Imperial China* 9, no. 1 (1988): 123–45.
[27] Wang Yuanchong, "Qing Dai Shi Xian Shu Yu Zhongguo Xian Dai Tong Yi Duo Min Zu Guo Jia de Xing Cheng 清代時憲書與中國現代統一多民族的形成," *She Hui Ke Xue*, no. 5 (2018): 185–203.; Fupeng Li, "Time as Norm: The Ritual Dimension of the Calendar Book and the Translation of Multi Temporality in Late Imperial China," in *Norms Beyond Empire: Law-Making and Local Normativities in Iberian Asia, 1500-1800*, ed. Manuel Bastias Saavedra (Brill, 2022).
[28] Guo Qingsheng, "Zhongguo Biao Zhun Shi Zhi Kao 中國標準時制考," *Zhongguo Keji Shiliao* 22, no. 3 (2001): 269–80.; Guo Qingsheng, "Jian Guo Chu Qi de Beijing Shi Jian 建國初期的北京時間," *Zhongguo Keji Shiliao* 24, no. 1 (2003): 1–5.; Endymion P. Wilkison, *Chinese History: A New Manual*, Fifth Edition (Digital) (Harvard University Asia Center, 2018) Section 39-40.
[29] Lewis Mumford, *Technics and Civilization* (Routledge, 1934), 14-18.

festivals in the "church's time" with the use of time units to organize work and labor in "merchant's time".[30]

While more recent work has demonstrated the contingencies in this process rather than an inevitable or determined outcome, clockwork technology has still served as a standard for exploring culture and technology.[31] One perspectives, for instance, views clocks as facing cultural barriers for its adoption in China.[32] Although Western missionaries introduced mechanical clocks into China in the late sixteenth century, the significance of the state in controlling time as well as the place of agriculture over urban life left clocks to be simply toys rather than instruments. As Carlo Cipolla writes, "The clock had little chance to play the role of a useful practical contrivance. For this to happen a complete change of society, of its structure, and of its needs had to occur."[33] Bertrand Gille makes a similar case for the role of culture. He classified technical culture in imperial China as a type of "blocked technical system". Techniques or skills had few incentives to introduce innovation or dynamic change.[34]

Another view has placed greater importance on design and the local conditions that shaped such needs. For example, Chinese astronomers and artisans experimented with different forms of power and geared instruments throughout history, although the large astronomical clocks did not necessarily employ the kind of verge and foliot technology that economic historians have deemed the most essential innovation.[35] Yet even after the introduction of clocks, the skills of clockmaking did travel. The imperial workshops began producing clocks in Beijing and were especially prolific in the eighteenth century. There were also producers in Guangzhou and in other centers around the empire.[36]

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[30] Jacques Le Goff, "Merchant's Time and Church's Time in the Middle Ages," in *Time, Work, and Culture in the Middle Ages*, by Jacques Le Goff, trans. Arthur Goldhammer (University of Chicago Press, 1982).
[31] Gerhard Dorhn-van Rossum, *History of the Hour: Clocks and Modern Temporal Orders*, trans. Thomas Dunlap (University of Chicago Press, 1996).; Paul Glennie and Nigel Thrift, *Shaping the Day: A History of Timekeeping in England and Wales 1300-1800* (Oxford University Press, 2009).
[32] Carlo M. Cipolla, *Clocks and Culture, 1300-1700* (W. W. Norton & Company, 1978).; David S. Landes, *Revolution in Time: Clocks and the Making of the Modern World*, 2nd ed. (Belknap Press, 2000).
[33] Cipolla, *Clocks and Culture*. 88
[34] Bertrand Gille, *The History of Techniques*, Vol 1: Techniques and Civilizations, trans. P. Southgate and T. Williamson (Gordon and Breach Science Publishers, 1986), 401-407.
[35] Joseph Needham et al., *Heavenly Clockwork: The Great Astronomical Clocks of Medieval China*, Second Edition (Cambridge University Press, 1986).
[36] Catherine Pagani, "Clockmaking in China under the Kangxi and Qianlong Emperors," *Arts Asiatiques* 50 (1995): 76–84.; Catherine Pagani, *"Eastern Magnificence & European Ingenuity": Clocks of Late Imperial China* (University of Michigan Press, 2001).; Guo Fuxiang, *Shi Jian de Li Shi Ying Xiang: Zhongguo Zhong Biao Shi Lun*

Moreover, in studies of the illustrations of time at the court, recent work has shown how the production of different timepieces was not simply about the need for a particular technology but about the communication with a specific audience and community. For example, collecting and displaying clocks and watches placed the owner in relation to the emperor, global networks, and the idea of universal rulership. But other displays of time reinforced connections to Chinese festivals, Manchu traditions, and religious attitudes of time.[37] Catherine Pagani and Li Youru make similar cases in studying the consumption and design of clocks. Clock designs reflected mutual influences in how to imagine one another and the value of time. The value to collect these items then continued to fit into local society.[38] While the workshops produced fewer clocks in the early nineteenth century, Li Youru has recently shown that the consumption of pocket-watches never fully declined. Elites and then the emerging merchant or middling classes competed to collect these items stimulating demand and the greater circulation of these objects into everyday life.[39]

Materializing Time

Yet there are limitations to these studies. First, much of this literature has focused on the category of things (e.g. "calendars", "clocks") yet not addressed how individuals engaged and used those things as historical objects. In practice, most people relied on multiple sets of information by which they came to know and find the time. Sometimes, this information was based on mechanical devices; and at other times, it came through activities or other environmental signals, including the sounds of daily life or the order of activities. Neither was this a product of premodern or modern experience. Rather finding and knowing the time was a cognitive act, and it required one to develop awareness toward tools and things to facilitate that process. It encompassed a range of different

Ji 時間的歷史映像: 中國鐘錶論集 (Gu gong cheng chu ban she, 2013).; Li Youru, *Zhong biao, zhong lou yu biao zhun shi jian: xi shi ji shi yi qi ji qi yu Zhongguo she hui de hu dong (1582-1949) 鐘錶, 鐘樓與標準時間: 西式計時儀器及其與中國社會的互動 (1582-1949)* (Zhengzhi daxue lishi xi 政治大學歷史系, 2012).; Tang Kaijian, *Setting Off from Macau: Essays on Jesuit History during the Ming and Qing Dynasties* (Brill, 2016), 257–281.

[37] Zhao Yanzhe, *Zi Jin Cheng Li de Shi Jian Ying Xiang : Tou Shi Qing Dai Gong Ting Hui Hua 紫禁城里的时间映像 : 透视清代宫廷绘画 [Images of Time from the Forbidden City: Penetrating Qing Dynasty Court Painting]* (Guangxi shifan daxue chuban she, 2023).

[38] Pagani, *Eastern Magnificence & European Ingenuity*.

[39] Li, *Zhong biao, zhong lou yu biao zhun shi jian,* Chapter 2, Chapter 3.

objects.[40] Some scholars refer to this as the "ecology" or "landscape" of time.[41] While much of the present scholarship on late imperial and modern China has focused on the questions of cultural beliefs, we first need to clarify how different media fit into different contexts and how various communities practiced and used those media to develop information on the time. The concepts of time were deeply connected to the types of media available for use, and these media informed each other. That is to say, instead of treating time as an independent factor, we need to more closely examine the practices by which individuals made time.[42]

The second issue in this literature is that because time is frequently treated as an abstract problem rather than a mediated phenomenon, scholars have rarely acknowledged that the information by which one came to trust and know when a particular time was came about through a large, embedded infrastructure that facilitated the circulation of that information for everyday use. In the twentieth century, we refer to such an overlapping network of collecting information and transmitting signals through electrical cables, satellite networks, and other media as a large, technological network.[43] It is made up of wires and transmitters. But it is also composed of people and their knowledge and even legal structures that enforce and enable it. As Paul Edwards describes this, it is a "knowledge infrastructure". "Knowledge infrastructures comprise robust networks of people, artifacts, and institutions that generate, share, and maintain specific knowledge about the human and natural worlds."[44]

Although the Qing dynasty was smaller in scale compared to what would become a global network coordinated on universal time, this comparison to infrastructures is insightful, because the

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[40] Kevin Birth, *Objects of Time: How Things Shape Temporality* (Palgrave Macmillan, 2012).
[41] Barbara Adam, *Timewatch: The Social Analysis of Time* (Polity Press, 1995); Barbara Adam, *Timescapes of Modernity: The Environment and Invisible Hazards* (Routledge, 1998); Barbara Adam, "The Multiplicity of Times: Contributions from the Tutzing Time Ecology Project: Introduction," *Time & Society* 11, no. 1 (2002): 87–88; Tsuo-Yu Cheng, "The Ecology of Social Time: An Outline of an Empirical Analytic Framework of The Sociology of Time," *Time & Society* 26, no. 2 (2017): 137–64.
[42] See also Peter Burke, "Reflections on the Cultural History of Time," *Viator* 35 (2004): 617–26.
[43] Claude Audoin and Bernard Guinot, *The Measurement of Time: Time, Frequency, and the Atomic Clock* (Cambridge University Press, 2001), 236-263.; Dennis McCarthy and P. Kenneth Seidelmann, *Time: From Earth Rotation to Atomic Physics* (Wiley-VCH, 2009), 249-261. For work on technological systems, see Thomas P. Hughes, *Networks of Power: Electrification in Western Society, 1880-1930* (Johns Hopkins University Press, 1983).; Trevor P. Hughes, "The Evolution of Large Technological Systems," in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, ed. Wiebe E. Bijker et al. (MIT Press, 2012).
[44] Paul Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (MIT Press, 2013), 17. For more on knowledge infrastructures, see Geoffrey C. Bowker, "Sustainable Knowledge Infrastructures," in *The Promise of Infrastructure*, ed. Nikhil Anand et al. (Duke University Press, 2018).

Qing maintained one of the largest land networks. I discuss this network in more detail in Chapter 1. But the network not only connected many spaces throughout the empire, it also brought together many different actors who impacted and shaped the process of distributing and making this time. It included data producers as well as copyists, carvers, printers, and porters. It involved local officials, local gentry, and other time specialists. It required the gathering of specialized materials from particular locations, and the recirculation of information into different media for niche audiences.

By introducing the idea of materiality and media to the study of time in China, my dissertation engages with a broader literature that uses objects for gaining insight into everyday life.[45] While some of the evidence for this network exists in archival records, my chapters focus on thinking with the objects that offer individual reflections on the continuities and changes that helped make public time something useful and accessible. In looking at the traces left on different media formats, including print, wood, metal, and stone, my work attempts to explore what time communication meant as a lived experience and practice of everyday life.

Chinese Scientific Instruments

One of the consequences of turning to a material approach to instruments of timekeeping is that these objects, often connected to other astronomical and mathematical instruments, introduce new evidence for understanding the popular culture in astronomy and astronomical practices across a variety of social groups in the Qing before the twentieth century. In looking to material artifacts, this approach highlights popular media, including encyclopedias, technical manuals, single-sheet prints, maps, wooden sundials, and mechanical celestial globes. And it allows one to revisit traditional narratives of scientific practices in the empire.

Initially, the history of science in China emerged in conjunction with the Needham Question or why China had not experienced the scientific revolution.[46] Although the Song dynasty produced important advancements in hydraulic technology, agriculture, and mechanics, later

[45] Dorothy Ko, *Every Step a Lotus: Shoes for Bound Feet* (University of California Press, 2001).; Marianne Hulbosch et al., eds., *Asian Material Culture* (Amsterdam University Press, 2009).; Anne Gerritsen and Giorgio Riello, *Writing Material Culture History* (Bloomsbury Publishing, 2015).; Yuhang Li, *Becoming Guanyin: Artistic Devotion of Buddhist Women in Late Imperial China* (Columbia University Press, 2020).; Bernasconi and Thürigen, *Material Histories of Time: Objects and Practices, 14th to 19th Centuries*.; Elizabeth LaCouture, *Dwelling in the World: Family, House, and Home in Tianjin China, 1860-1960* (Columbia University Press, 2021).
[46] Joseph Needham, *The Grand Titration: Science and Society in East and West* (University of Toronto Press, 1969).

dynasties experienced slower rates of growth. Mark Elvin treated this pattern as what he called the "high-equilibrium trap".[47] As long as productivity with current technologies was sufficient to meet demands, there were few incentives to promote technical innovation. Joseph Levenson, on the other hand, viewed the problem as one of culture. He argued that even though the early Qing engaged in an intellectual culture that valued empirical evidence, this methodology never culminated in a radical revision against tradition or an experimentalist philosophy.[48] But in Needham's original formulation, although Needham agreed with Levenson that traditional Chinese beliefs about nature did not result in a mechanistic philosophy, Needham ultimately centered on the cause of bureaucracy. According to Needham's hypothesis, Chinese bureaucracy was both the boon for early technical innovation, but also the bane of long-term development, because it focused on maintaining stability.[49]

Although the Needham Question has continued to engage a variety of social scientists, in the 80s and 90s, historians of Chinese science largely eschewed civilizational comparison to instead prioritize historical practices of science on their own terms.[50] Carla Nappi and Dagmar Schäfer, for instance, conducted biographical studies of Li Shizhen 李時珍 (1518-1593) and Song Yingxing 宋應星 (1587-1666) respectively to explain the various methods by which these scholars

[47] Mark Elvin, *The Pattern of the Chinese Past* (Stanford University Press, 1973), 298-315.
[48] Joseph R. Levenson, "The Abortiveness of Empiricism in Early Ch'ing Thought," *The Far Eastern Quarterly* 13, no. 2 (1954): 155–65.
[49] Needham, *The Grand Titration*. 203, 286-287
[50] Nathan Sivin, "Why the Scientific Revolution Did Not Take Place in China – Or Didn't It?," *Chinese Science* 5 (1982), 45-66.; Roger Hart, "Beyond Science and Civilization: A Post-Needham Critique," *East Asian Science, Technology & Medicine* 16 (1999): 88–114.; Francesca Bray, "From Needham to EASTS, or Why History Matters," *East Asian Science, Technology and Society: An International Journal* 13, no. 2 (2019): 317–21.; Florence Hsia and Dagmar Schäfer, "History of Science, Technology, and Medicine: A Second Look at Joseph Needham," *Isis* 110 (2019): 94–99. For work that has continued to engage and respond to Needham, see Pervez Hoodbhoy, *Islam and Science: Religious Orthodoxy and the Battle for Rationality* (Zed Books, 1991).; Toby Huff, *The Rise of Early Modern Science: Islam, China, and the West* (Cambridge University Press, 1993).; George Saliba, *Islamic Science and the Making of the European Renaissance* (MIT Press, 2007).; Justin Yifu Lin, "The Needham Puzzle, the Weber Question, and China's Miracle: Long-Term Performance Since the Sung Dynasty," *China Economic Journal* 1, no. 1 (2008): 63–95.; Qiang Chen, "The Needham Puzzle Reconsidered: The Protection of Industrial and Commercial Property Rights," *Economic History of Developing Regions* 27, no. 1 (2012): 38–66.; H. Floris Cohen, *How Modern Science Came into the World: Four Civilizations, One 17th-Century Breakthrough* (Amsterdam University Press, 2012).; Dengjian Jin, *The Great Knowledge Transcendence: The Rise of Western Science and Technology Reframed* (Palgrave Macmillan, 2016); Joel Mokyr, *A Culture of Growth: The Origins of the Modern Economy* (Princeton University Press, 2016). Colin Mackerras, "Global History, the Role of Scientific Discovery and the 'Needham Question': Europe and China 16th to 19th Centuries," in *Global History and New Polycentric Approaches: Europe, Asia and the Americas in a World Network System*, ed. Manuel Pérez García and Lucio De Sousa (Springer Nature Singapore, 2018).

valued and transmitted knowledge.[51] Benjamin Elman similarly explored how the late Ming traditions of "natural studies" and "the investigation of things" transformed into the modern categories of "science".[52] Building on his earlier studies in philology, Elman documented how Chinese scholars in the eighteenth century selectively appropriated aspects of Western Learning.[53] Similar challenges of cultural translation were also involved when missionaries took on the task of translating textbooks into Chinese.[54]

Within this wider shift toward studying practices on their own terms, some work has examined tools and instruments. In collaboration with museums and archaeologists, several scholars in China have created surveys of astronomical and medical instruments including recent work that has focused on star charts and maps.[55] One of the most comprehensive surveys of astronomical instruments explains possible reconstructions of ancient instruments from the Han dynasty as well as detailed explanations of extant instruments from the collection of the Palace Museum. The chapters include sundials, globes, measuring instruments, demonstration models, and surveying instruments. In addition to categorizing by type, the authors also explore instruments that are based on Western models as well as "folk" instruments. Under "folk" or "popular" instruments, the authors include water-clocks, incense clocks, some sundials, and instruments attributed to individuals.[56] While the book offers an important starting point for studying

[51] Carla Nappi, *The Monkey and the Ink-Pot: Natural History and Its Transformations in Early Modern China* (Harvard University Press, 2009).; Dagmar Schäfer, *The Crafting of the 10,000 Things: Knowledge and Technology in Seventeenth-Century China* (University of Chicago Press, 2011).

[52] Benjamin A. Elman, *"*Jesuit Scientia and Natural Studies in Late Imperial China, 1600-1800,*"* *Journal of Early Modern History* 6, no. 3 (2002): 209–32; Benjamin A. Elman, *"*From Pre-Modern Chinese Natural Studies 格致學 To Modern Science 科學 In China,*"* in *Mapping Meanings: The Field of New Learning in Late Qing China*, ed. Michael Lackner and Natascha Vittinghoff (Brill, 2004); Benjamin A. Elman, *On Their Own Terms: Science in China 1550-1900* (Harvard University Press, 2005).

[53] Benjamin A. Elman, *From Philosophy to Philology: Intellectual and Social Aspects of Change in Late Imperial China* (Council on East Asian Studies, 1984).

[54] Elman, *On Their Own Terms: Science in China 1550-1900*.; For additional studies, see Jing Tsu and Benjamin A. Elman, eds., *Science and Technology in Modern China: 1880s-1940s* (Brill, 2014).

[55] Li Liang, *Can Lan Xing He: Zhongguo Gu Dai Xing Tu 燦爛星河: 中國古代星圖* (Kexue chuban she, 2021); Pan Nai, *Colour Printing: The History of Ancient Astronomical Instruments of China 彩圖本：中國古天文儀器史* (Shaanxi jiao yu chu ban she, 2005); Pan Nai, *Zhongguo Heng Xing Guan Ce Shi 中國恆星觀測史* (Xue lin chu ban she, 1989); Gu gong bo wu yuan (China), *Qing Gong Xi Yang Yi Qi 清宮西洋儀器*, Di 1 ban., ed. Lu Liu, Gu Gong Bo Wu Yuan Cang Wen Wu Zhen Pin Quan Ji = Complete Collection of Treasures of the Palace Museum ; 58 (Shang wu yin shu guan (Xianggang) gu fen you xian gong si, 1998); Guan Xueling, *Ri Sheng Yue Heng: Gu Gong Bo Wu Yuan Cang Qing Dai Zhong Biao 日升月恒：故宮博物院藏清代钟表* (Zi jin cheng chu ban she, 2009). Guan Xueling, *Qing Dai Gong Ting Yi Xue Yu Yi Xue Wen Wu 清代宮廷醫學與醫學文物* (Zi jin cheng chu ban she, 2008).

[56] Pan, *Colour Printing*.

instruments, the authors typically discuss the mathematical context of instruments rather than situate instruments in their broader social or cultural context, and they rarely discuss a specific instrument as a historical object.

Some researchers like Christopher Cullen and Thatcher Deane have investigated native instruments in China, but a larger literature has focused on the diffusion of instruments through missionaries and diplomats.[57] Instruments were an important part of the Jesuit calendar reforms, and just like translations they required strategies of persuasion to build trust.[58] Although earlier models of missionaries in China focused on impact and response, more recent models have studied missionaries through collaboration and interaction.[59] Hence, Zhang Baichun has written one of the most important works on instruments from the seventeenth century, describing the process of acculturation in instruments through the idea of "Europeanization".[60] While European models became the primary standard for constructing these instruments, the new instruments were also combined with historical knowledge creating a hybrid form of instrument. Allen Chapman has made similar observations of the hybrid form of the new instruments built under Ferdinand Verbiest (1628-1688).[61]

Recently, scholars have used instruments to explore additional themes of cross-cultural exchanges in this period of "old" Western Learning. Mathematical and surveying instruments continued to flow from Europe to China as missionaries participated in mapping projects in the eighteenth century.[62] Inventories and catalogues of mission houses also document how instruments

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[57] Cullen, *Heavenly Numbers*; Morgan, *Astral Science in Early Imperial China*; Thatcher E. Deane, "Instruments and Observation at the Imperial Astronomical Bureau during the Ming Dynasty," *Osiris* 9 (1994): 126–40.; Thatcher E. Deane, "The Chinese Imperial Astronomical Bureau: Form and Function of the Ming Dynasty 'Qintianjian' from 1365 to 1627" (Phd Dissertation, University of Washington, 1989).

[58] Ping-Yi Chu, "Trust, Instruments, and Cross-Cultural Scientific Exchanges: Chinese Debate over the Shape of the Earth, 1600–1800," *Science in Context* 12, no. 3 (1999): 385–412.

[59] Nicolas Standaert, *Methodology in View of Contact Between Cultures: The China Case in the 17th Century* (Centre for the Study of Religion and Chinese Society, 2002).

[60] Zhang Baichun, *Ming Qing Ce Tian Yi Qi Zhi Ou Hua: Shi Qi, Shi Ba Shi Ji Chuan Ru Zhongguo de Ouzhou Tian Wen Yi Qi Ji Shu Ji Qi Li Shi Di Wei* 明清測天儀器之歐化: 十七，十八世紀傳入中國的歐洲天文儀器技術及其歷史地位 (Liaoning jiao yu chu ban she, 2000).

[61] Allan Chapman, "Tycho Brahe in China: The Jesuit Mission to Peking and the Iconography of European Instrument-Making Processes," *Annals of Science* 41, no. 5 (1984): 417–43; Baichun Zhang, "The Introduction of European Astronomical Instruments and the Related Technology into China during the Seventeenth Century," *East Asian Science, Technology & Medicine* 20 (2003): 99–131

[62] Joanna Waley-Cohen, *The Sextants of Beijing: Global Currents in Chinese History* (W. W. Norton & Company, 1999); Joanna Waley-Cohen, "China and Western Technology in the Late Eighteenth Century," *The American Historical Review* 98, no. 5 (1993): 1525–44,.; Florence Hsia, *Sojourners in a Strange Land: Jesuits and Their*

were both concentrated in Beijing but also circulated far more widely than understood from surveys and general narratives.[63] Instruments were also a part of diplomatic exchange, as the Macartney embassy famously transported complicated mechanisms that they brought to China.[64] Instruments were also a part of global exchanges. Jean Joseph Marie Amiot (1718-1793) and the Manchu prince Hongwu 弘昉 (1743-1811) conducted electrical experiments in Beijing.[65] And as Eugenio Menegon has argued, the study of instruments in context can offer one way to write a global microhistory of encounters and exchanges.[66]

Instruments have also been influential in looking at the nineteenth century. Some mathematical and optical instruments were sold for tea.[67] Chinese painters were involved in producing botanical illustrations used in natural history.[68] Protestant missionaries not only translated terms, but they were also involved in displaying instruments in reading rooms, such as globes, telegraph equipment, firearms, and artillery.[69] New technologies, such as photography,

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Scientific Missions in Late Imperial China (University of Chicago Press, 2009).; Mario Cams, "Converging Interests and Scientific Circulation between Paris and Beijing (1685-1735): The Path towards a New Qing Cartographic Practice," *Revue d'histoire Des Sciences* 70, no. 1 (2017): 47–78; Mario Cams, *Companions in Geography: East-West Collaboration in the Mapping of Qing China (c.1685-1735)* (Brill, 2017).

[63] Noël Golvers, "The Instrument Collection of Prince-Bishop Ernest of Bavaria (Liège, 1612), Nicolas Trigault & Johann Terrentius, and the Chinese Destiny of Some of Its Items," *Archives Internationales d'Histoire Des Sciences* 62 (2012): 691–701; Noël Golvers, "Circulation of Knowledge between Europe and China in the 17th–18th Centuries: The Role of Material Objects, from Gadgets to Instruments," *Almagest* 8, no. 1 (2017): 77–117.

[64] J. L. Cranmer-Byng and Trevor H. Levere, "A Case Study in Cultural Collision: Scientific Apparatus in the Macartney Embassy to China, 1793," *Annals of Science* 38, no. 5 (1981): 503–25; Simon Schaffer, "Instruments as Cargo in the China Trade," *History of Science* 44, no. 2 (2006): 217–46; Guo Fuxiang, "Presents and Tribute: Exploration of the Presents Given to the Qianlong Emperor by the British Macartney Embassy," *Extrême-Orient Extrême-Occident* 43 (2019): 143-172; Harriet Zurndorfer, "Science Without Modernization: China's First Encounter With Useful And Reliable Knowledge From Europe," 2004, 1–35, www.lse.ac.uk/Economic-History/Assets/Documents/Research/GEHN/GEHNConferences/conf4/Conf4-HZurndorfer.pdf.

[65] Alexander Statman, "A Forgotten Friendship: How a French Missionary and a Manchu Prince Studied Electricity and Ballooning in Late Eighteenth Century Beijing," *East Asian Science, Technology & Medicine* 46 (2017): 89–118.

[66] Eugenio Menegon, "Telescope and Microscope: A Micro-Historical Approach to Global China in the Eighteenth Century," *Modern Asian Studies* 54, no. 4 (2020): 1315–44.

[67] Mary Augusta Brazelton, "Pocket Sundial with Chinese Characters, by Samuel Porter, English, c. 1825," in *Materials for the History of Science: A Whipple Museum Festschrift to Celebrate the Directorship of Professor Liba Taub*, ed. Joshua Nall et al. (Whipple Museum of the History of Science, 2022), 139.

[68] Fa-ti Fan, *British Naturalists in Qing China: Science, Empire, and Cultural Encounter* (Harvard University Press, 2004).

[69] Adrian A. Bennett, *John Fryer: The Introduction of Western Science and Technology into Nineteenth-Century China* (Harvard University Asia Center, 1967), 49.; Knight Biggerstaff, "Shanghai Polytechnic Institution and Reading Room: An Attempt to Introduce Western Science and Technology to the Chinese," *Pacific Historical Review* 25, no. 2 (1956): 127–49. For more on the context of translation, see David Wright, *Translating Science: The Transmission of Western Chemistry Into Late Imperial China, 1840-1900* (Brill, 2000).; Michael Lackner et al., eds., *New Terms for New Ideas: Western Knowledge and Lexical Change in Late Imperial China* (Brill, 2001).

telegraphy, and the steam engine also circulated through translations and specific objects.[70] Medical instruments too had their own trajectories.[71]

Yet most studies have focused on instruments through texts rather than studying instruments as sources of scientific practice. For example, the field has shown the potential to look at practice as a way to recover the histories of translators and other intermediaries, to bring to light marginalized actors from other contexts.[72] Recent work has increasingly shown the significance of looking at state archives, book history editions, and manuscripts.[73] The study of manuscripts in Chinese and European libraries has particularly helped historians rediscover not only how individuals tried to practice certain medical beliefs but also showed how Western Learning often had more nuanced and unexpected lives than published history tends to imply.[74] On the other hand, histories of knowledge have also pointed to the significance of using material history as a methodology. The study of things has opened up new questions for finding artisans and their role

[70] Erik Baark, *Lightning Wires: The Telegraph and China's Technological Modernization, 1860-1890* (Greenwood Press, 1997).; Tom Mullaney, *The Chinese Typewriter: A History* (MIT Press, 2018).; Hsien-ch'un Wang, *Western Technology and China's Industrial Development: Steamship Building in Nineteenth-Century China, 1828-1895* (Palgrave Macmillan, 2022).; Oliver Moore, *Photography in China: Science, Commerce, and Communication* (Routledge, 2022).

[71] Ari Larissa Heinrich, *The Afterlife of Images: Translating the Pathological Body between China and the West* (Duke University Press, 2008); Bridie Andrews, *The Making of Modern Chinese Medicine, 1850-1960* (UBC Press, 2013), Chapter 8; Howard Chiang, *After Eunuchs: Science, Medicine, and the Transformation of Sex in Modern China* (Columbia University Press, 2018).

[72] Kapil Raj, *Relocating Modern Science: Circulation and the Construction of Knowledge in South Asia and Europe, 1650-1900* (Palgrave Macmillan, 2007).; Simon Schaffer et al., eds., *The Brokered World: Go-Betweens and Global Intelligence, 1770-1820* (Science History Publications, 2009).; Bernard Lightman et al., eds., *The Circulation of Knowledge Between Britain, India and China: The Early-Modern World to the Twentieth Century* (Brill, 2013).

[73] Ping-Ying Chang, *The Chinese Astronomical Bureau, 1620-1850: Lineages, Bureaucracy, and Technical Expertise* (Routledge, 2022).; Catherine Jami, *The Emperor's New Mathematics: Western Learning and Imperial Authority during the Kangxi Reign (1662-1722)* (Oxford University Press, 2012); Catherine Jami, "Revisiting the Calendar Case (1664-1669): Science, Religion, and Politics in Early Qing Beijing," *The Korean Journal for the History of Science* 37, no. 2 (2015): 459–77.; Daniel Asen, *Death in Beijing: Murder and Forensic Science in Republican China* (Cambridge University Press, 2016).; Yuming He, *Home and the World: Editing the "Glorious Ming" in Woodblock-Printed Books of the Sixteenth and Seventeenth Centuries* (Harvard University Asia Center, 2013).; Suyoung Son, *Writing for Print: Publishing and the Making of Textual Authority in Late Imperial China* (Harvard University Asia Center, 2018).; Yinzeng Wei, *Scholars and Their Marginalia in Late Imperial China* (Brill, 2022).

[74] Ying Zhang, "Household Healing: Rituals, Recipes, and Morals in Late Imperial China" (Phd Dissertation, Johns Hopkins University, 2017); Xu Jie and Shi Yunli, "Pang Diwo, Sun Yuanhua 'Ri Gui Tu Fa' Chu Tan: Jian Lun Niu Jin Ben Tian Wen Lue Zhong de San Zhong Gui Yi 龐迪我，孫元化'日晷圖法'初探：兼論牛津本天文略中的三種晷儀," *Zi Ran Ke Xue Shi Yan Jiu* 25, no. 2 (2006): 149–58.; Gong Yingyan, "Xu Guangqi Wei Kan Bi Ji 'Kai Cheng Ji Yao' Chu Tan 徐光啓未刊筆記'開成紀要'初考," *Fudan Xuebao (Shehui Kexue Ban)* 59, no. 4 (2017): 53–60.

in the communication and transmission of practices.[75] In sum, a material history and object-oriented approach to scientific practices in the Qing dynasty can introduce new evidence for studying knowledge in making and offer a methodology for recovering a more global perspective on science.

Moreover, this focus on practice and instruments also fills in a gap in our understanding of practices in the late eighteenth and early nineteenth centuries, between the periods thought of as first and second waves of Westernization. This period in the Jiaqing and the Daoguang reigns was once characterized as a period of decline.[76] However, in recent years, studies of statecraft and reform have increasingly recognized the need to explore how this period also pioneered the critical pathways for long-term reform with studies on Bao Shichen's philosophy, local gentry activism in Suzhou, and innovations in management in Shaanxi and other provinces.[77] Matthew Mosca has been a pioneer in revising this narrative in terms of the broader history of science with his work on the integration of geography and the intellectual study of Inner Asia.[78] The history of the book has also made inroads here because this period was also a period of increased commercial publication.[79] Some scholars in China have also tried to revisit these narratives with closer attention to the circulation and reprinting of sources. These scholars refer to their work as a type of "new-old" Westernization to try to point towards the innovation in this period and yet recognize

[75] Dorothy Ko, *The Social Life of Inkstones: Artisans and Scholars in Early Qing China* (University of Washington Press, 2017); Kyoungjin Bae, "Joints of Utility, Crafts of Knowledge: The Material Culture of the Sino-British Furniture Trade during the Long Eighteenth Century (2016)" (Phd Dissertation, Columbia University, 2016).
[76] Susan Mann Jones and Philip A. Kuhn, "Dynastic Decline and the Roots of Rebellion," in *The Cambridge History of China, Late Ch'ing 1860-1911, Part I*, vol. 10, ed. John K. Fairbank and Denis Twitchett (Cambridge University Press, 1978).
[77] Daniel McMahon, "Dynastic Decline, Heshen, and the Ideology of the Xianyu Reforms," *Tsing Hua Journal of Chinese Studies* 38, no. 2 (2008): 231–55.; William T. Rowe, "Introduction: The Significance of the Qianlong-Jiaqing Transition in Qing History," *Late Imperial China* 32, no. 2 (2011): 74–88.; Seunghyun Han, *After the Prosperous Age: State and Elites in Early Nineteenth-Century Suzhou* (Harvard University Asia Center, 2016).; Jane Kate Leonard, *Stretching the Qing Bureaucracy in the 1826 Sea-Transport Experiment* (Brill, 2018); Daniel McMahon, *Rethinking the Decline of China's Qing Dynasty: Imperial Activism and Borderland Management at the Turn of the Nineteenth Century* (Routledge, 2015); William T. Rowe, *Speaking of Profit: Bao Shichen and Reform in Nineteenth-Century China* (Harvard University Asia Center, 2018).
[78] Matthew W. Mosca, "The Literati Rewriting of China in the Qianlong-Jiaqing Transition," *Late Imperial China* 32, no. 2 (2011): 89–132; Matthew W. Mosca, *From Frontier Policy to Foreign Policy: The Question of India and the Transformation of Geopolitics in Qing China* (Stanford University Press, 2013).
[79] Tsuen-Hsuin Tsien, *Science and Civilisation in China, Part 1, Paper and Printing* (Cambridge University Press, 1985), 190.; Cynthia J. Brokaw, "Publishing, Society, and Culture in Pre-Modern China: The Evolution of Print Culture," *International Journal of Asian Studies* 2, no. 1 (2005): 135–65; Cynthia J. Brokaw, "Book History in Premodern China: The State of the Discipline I," *Book History* 10 (2007): 253–90; Cynthia J. Brokaw, *Commerce in Culture: The Sibao Book Trade in the Qing and Republican Periods* (Harvard University Asia Center, 2007), 8-19.

that it is different from later encounters.[80] My dissertation consequently draws close attention to this period and demonstrates that this period was a vibrant moment of discussion and exchange. Contrary to the image of decline and non-engagement, I argue that this period transformed Western Learning from a limited topic at court into a wider social discussion, a kind of complement to what has been called the expansion of "polite" and "practical" astronomy in Western historiography.[81]

Temporality and Modernity

Another consequence in using a material approach is the need to revise our present understanding about the markers for modernity. Time consciousness has changed over time. For many writers, this is an important feature of modernization. It also has implications for explaining how China entered this global process. But historians have argued how and when this happened.[82]

Scholars have long focused on premodern and modern dichotomies. At one point, social theorists emphasized cyclical versus linear cultures of time and argued that cyclical times were associated with primitive societies compared to modern visions of linear, progressive time.[83] Although academics have largely discarded this evolutionary approach, social histories of time

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[80] Wang Erh-min, "Liang Tingkan Dui Yu Xi Fang Zhi Ren Shi Ji Qi Kai Xin Shi Ye 梁廷枏對於西方之認識及其開新視野," *Tai Wan Shi Da Li Shi Xue Bao* 35 (2006): 115–39; Wang Erh-min, "Jin Dai Ke Ji Xian Qu Xu Chaojun Zhi 'Gao Hou Meng Qiu' 近代科技先驅徐朝俊之'高厚蒙求,'" *Shilin*, no. 2 (2012): 77–95; Han Qi and Liang Deng, "Ke Xue Xin Zhi Zai Dong Nan Ya He Zhongguo Yan Hai Cheng Shi de Chuan Bo: Yi Jiaqing Zhi Xianfeng Nian Jian Tian Wang Xing Zhi Shi de Jie Shao Wei Li 科學新知在東南亞和中國沿海城市的傳播：以嘉慶至咸豐年間天王星知識的介紹為例," *Zi Ran Bian Zheng Fa Tong Xun* 38, no. 6 (2016): 60–67.; Chen Tuo, "Cong Xu Chaojun Dao Xu Jiyu: Jia Dao Shi Qi Xin Jiu Xi Xue de Zhi Shi Mai Luo 從徐朝俊到徐繼畬：嘉道時期新舊西學的知識脈絡," *Jin Dai Shi Yan Jiu*, no. 3 (2023): 122–37; Chen Tuo, "Cong Yang Guangxian Dao Wei Yuan: Qing Dai Wen Hua Bao Shou Zhu Yi de Wen Ben Mai Luo 從楊光先到魏源：清代文化保守主意的文本脈絡," *Qing Shi Yan Jiu*, no. 3 (2023): 77–91.

[81] Alice N. Walters, "Tools of Enlightenment: The Material Culture of Science in Eighteenth-Century England" (Phd Dissertation, University of California Berkeley, 1997), 174-298.

[82] Goff, "Merchant's Time and Church's Time in the Middle Ages"; Jacques Le Goff, "Labor Time in the 'Crisis' of the Fourteenth Century: From Medieval Time to Modem Time," in *Time, Work, and Culture in the Middle Ages*, by Jacques Le Goff, trans. Arthur Goldhammer (University of Chicago Press, 1982).; E. P. Thompson, "Time, Work-Discipline, and Industrial Capitalism," *Past & Present* 38, no. 1 (1967): 56–97.; Paul Glennie and Nigel Thrift, "Reworking E. P. Thompson's `Time, Work-Discipline and Industrial Capitalism'," *Time & Society* 5, no. 3 (1996): 275–99; Vanessa Ogle, "Time, Temporality and the History of Capitalism," *Past & Present* 243, no. 1 (2019): 312–27.

[83] Emlie Durkheim, *The Elementary Forms of Religious Life*, trans. Karen Fields (The Free Press, 1995) 8-18.; Claude Levi-Strauss, *The Savage Mind* (Weidenfeld and Nicolson, 1966). For overviews of these theories, see Nancy D. Munn, "The Cultural Anthropology of Time: A Critical Essay," *Annual Review of Anthropology* 21 (1992): 93–123; Alfred Gell, *The Anthropology of Time: Cultural Constructions of Temporal Maps and Images* (Routledge, 2020).

still reflect these binaries. For instance, linear and cyclical time are especially associated with rural and urban divides. According to this view, preindustrial, agrarian societies primarily followed "natural cycles" of annual seasons, religious festivals, and particular events. In contrast, modern forms of time became increasingly measured, abstract, and controlled through technologies and external devices.[84] These divisions have, therefore, tended to focus on the role of the eighteenth and nineteenth centuries in creating this division in experiencing abstract versus concrete time.

In addition to framing this as an internal change in Western society, scholars have tried to define how these practices impacted others, especially through the lenses of colonialism and capitalism. On the one hand, colonization created legal regimes that forced populations to switch their practices and integrate local times into mechanical visions of "metronomic society".[85] New visions of mass participation in the nineteenth century through universal education and military service transformed rural communities. These efforts became global projects which had impacts both within and between states.[86] On the other hand, new technologies of communication and transportation produced alternative rhythms of integration. Simultaneously, to coordinate these processes, international states had to negotiate standards that enabled and facilitated the production of increasing connection.[87]

In Chinese historiography, various attempts to explore changes in time have suggested different turning points ranging from the 1860s to the 1950s. According to one view, because of China's agricultural base, traditional society emphasized "natural cycles", seasonal events, and the

[84] Moishe Postone, *Time, Labor, and Social Domination: A Reinterpretation of Marx's Critical Theory* (Cambridge University Press, 1993), 201-202; Pierre Bourdieu, *The Logic of Practice*, trans. Richard Nice (Stanford University Press, 1990), 98-111; Anthony Giddens, *The Consequences of Modernity* (Stanford University Press, 1990), 17-21.
[85] Giordano Nanni, *The Colonisation of Time: Ritual, Routine and Resistance in the British Empire* (Manchester University Press, 2012); Jean Comaroff, "Missionaries and Mechanical Clocks: An Essay on Religion and History in South Africa," *The Journal of Religion* 71, no. 1 (1991): 1–17; Michael Young, *The Metronomic Society: Natural Rhythms and Human Timetables* (Harvard University Press, 1988).
[86] Michael O'Malley, *Keeping Watch: A History of American Time* (Smithsonian Institution Press, 1990); Alexis McCrossen, *Marking Modern Times: A History of Clocks, Watches, and Other Timekeepers in American Life* (University of Chicago Press, 2013); Carlene E. Stephens, *On Time: How America Has Learned to Live by the Clock* (Smithsonian Institution Press, 2002); Avner Wishnitzer, *Reading Clocks, Alla Turca: Time and Society in the Late Ottoman Empire* (University of Chicago Press, 2015); Stefan Tanaka, *New Times in Modern Japan* (Princeton University Press, 2004).
[87] Barak, *On Time*; Ogle, "Whose Time Is It? The Pluralization of Time and the Global Condition, 1870s—1940s"; Ogle, *The Global Transformation of Time, 1870–1950*; Peter Galison, *Einstein's Clocks and Poincaré's Maps: Empires of Time* (W. W. Norton & Company, 2003); Bartky, *One Time Fits All*; Derek Howse, *Greenwich Time and the Discovery of the Longitude* (Oxford University Press, 1980).

cyclical nature of time.[88] While the 19th century witnessed incredible changes regarding China's position in the global economy and the rise of social and political reform, most villages maintained seasonal labor and followed the lunisolar calendar. Even after the state adopted the Gregorian calendar in 1912, village communities continued to emphasize ritual.[89] The Republic of China had little ability to impose a single system across the large space of China, and the state came to recognize multiple time zones to recognize local influences even though they created new rhythms of social life.[90] For the average villager, according to this interpretation, it was only the Second World War and the Communist Revolution that created the disruptions to daily rhythm, and the greater affordability of mechanical clocks upon which it relied, to create the transformations toward global metronomic society framed within a single time defined by Beijing.[91]

Nevertheless, there is another perspective that links transformation more closely to urban experience and semi-colonialism in the treaty ports. Hong Kong and Shanghai were important sites for the implementation of clock time.[92] Foreign businesses were able to produce cheaper watches by the 1860s that reached an active middle class seeking these objects.[93] Similar to Ottoman reforms, the Qing state also implemented regimented schedules that were meant to inculcate discipline among pupils and troops.[94] As Luke Kwong writes, by the 1890s, Yan Fu's translation of Darwin gave rise to the discovery of linear time and the formation of nationalist narratives

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[88] Joseph Needham, "Time and Knowledge in China and the West," in *The Voices of Time: A Cooperative Survey of Man's Views of Time as Expressed by the Sciences and by the Humanities*, ed. James T. Fraser (University of Massachusetts Press, 1981); Derk Bodde, *Chinese Thought, Society, and Science: The Intellectual and Social Background of Science and Technology in Pre-Modern China* (University of Hawai'i Press, 1991); Wilkinson, *Chinese History*; Erik Zürcher and Chun-chieh Huang, eds., *Time and Space in Chinese Culture* (Brill, 1997); Marcel Granet, *La Pensée Chinoise* (Albin Michel, 1968).

[89] Hsiao-tung Fei, *Peasant Life in China: A Field Study of Country Life in the Yangtze Valley* (E. P. Dutton & Company, 1939), 144-153.

[90] Wilkinson, *Chinese History,* 40.10.; Elizabeth Vander Ven, "It's Time for School: The Introduction of the New Calendar in Haicheng County Primary Schools, Northeast China, 1905-1919," *Twentieth-Century China* 32, no. 2 (2007): 60–83; Henrietta Harrison, *The Making of the Republican Citizen: Political Ceremonies and Symbols in China, 1911-1929* (Oxford University Press, 2000), 66-71.

[91] Wilkinson, *Chinese History,* 40.10.; Guo, "Zhongguo Biao Zhun Shi Zhi Kao 中國標準時制考"; Guo, "Jian Guo Chu Qi de Beijing Shi Jian 建國初期的北京時間."; Wang Erh-min, *Ming Qing Shi Dai Shu Min Wen Hua Sheng Huo 明清時代庶民文化生活* (Yuelu shu she, 2002), 25-33.

[92] Qin Shao, *Culturing Modernity: The Nantong Model, 1890-1930* (Stanford University Press, 2004), 86-101; Wen-hsin Yeh, *Shanghai Splendor: Economic Sentiments and the Making of Modern China, 1843-1949* (University of California Press, 2007), 79-100.

[93] Li, *Zhong biao, zhong lou yu biao zhun shi jian*.

[94] Huang Jinlin, *Li Shi, Shen Ti, Guo Jia: Jin Dai Zhongguo de Shen Ti Xing Cheng (1895-1937) 歷史，身體，國家: 近代中國的身體形成（1895-1937）* (Xin xing chu ban she, 2006), 148-149.; Nathan Schillinger, *The Body and Military Masculinity in Late Qing and Early Republican China: The Art of Governing Soldiers* (Lexington Books, 2016), 95-132.

toward a deep past and comparative theory of progress.[95] Moreover, telegraphs, newspapers, railroads all had consequences for breaking down the barriers of space and creating faster access to knowledge and information.[96]

Yet what much of this literature oversimplifies is the complexity involved in finding time, and the ways in which practices rarely divide so easily between "abstract" and "concrete" attitudes. Recent work in the history of temporalities has offered a new approach that tries to break down these dichotomies of premodern and modern time by focusing more closely on the specific and local practices that rendered time visible, material, and accessible to individuals and communities.[97] Instead of defining time as an external entity, the history of temporalities engages with the multiple practices and contexts that informed time. Hence, Kevin Birth writes of fourteenth-century York not as a place defined by "natural" cycles, but one in which many signals and indicators had to be constantly calibrated against each other to notify workers of breaks and time. These tools included celestial indicators indeed, but also animal sounds, tolling bells, units of fixed duration (amount of time it takes to walk between two sites), oral reading, and so on.[98]

Similarly, Matthew Champion and Rachel Rich illustrate how recording time and reading time may incorporate multiple objects and things depending on the context. For instance, Champion discusses how musical notation and rhythms acquired temporal features as church spaces increasingly relied on fixed tools for marking time.[99] Rich, on the other hand, examines the diaries of women at the turn of the 19th century as women both structured domestic lives within standardizing measurements of family timepieces and state calendars, while also creating personal

[95] Luke S. K. Kwong, *"*The Rise of the Linear Perspective on History and Time in Late Qing China, c. 1860-1911,*"* *Past & Present* 173 (2001): 157–90.
[96] Chang-Tze Hu, *"*Historical Time Pressure: An Analysis of Min Pao (1905-1908),*"* in *Time and Space in Chinese Culture*, ed. Erik Zürcher and Chun-chieh Huang (Brill, 1997).; Joan Judge, *Print and Politics: 'Shibao' and the Culture of Reform in Late Qing China* (Stanford University Press, 1997).; Baark, *Lightning Wires: The Telegraph and China's Technological Modernization, 1860-1890*; Elisabeth Köll, *Railroads and the Transformation of China* (Harvard University Press, 2019).
[97] Matthew S. Champion, *"*The History of Temporalities: An Introduction,*"* *Past & Present* 243, no. 1 (2019): 247–54; Birth, *Objects of Time*; Nitin Sinha, *Against the Fetishisation of Plural Time: Rethinking Ways of Doing a Social History of Time* (De Gruyter, 2025).
[98] Birth, *Objects of Time,* 55-67
[99] Matthew S. Champion, *The Fullness of Time: Temporalities of the Fifteenth-Century Low Countries* (University of Chicago Press, 2017), 90-106.

times through marking family rituals, celebrations, and events.[100] The acts of recording, building memories, compiling materials layered personal creation on top of public forms of time.[101]

Consequently, my dissertation has an impact on shifting the boundaries on temporality to an earlier moment. Instead of viewing Qing China as structured by a rupture between "modern" and "premodern" time in the 1860s, I instead turn to the multiple ways that different actors and communities constructed and built time as an overlapping set of practices. This attention to temporality means I focus on the relationship between different things. Calendars were critical, but they were also material artifacts. They had many forms, shapes, and relationships; and they were redesigned for new contexts to give new meanings to time. But calendars were simply one type of indicator for finding time. Individuals also engaged in other practices of measuring hours that required the action of tools and technologies, including charts, sundials, drawing instruments, audio signals, and even mechanical clocks. While these tools and devices were not always solving the same problems, they each had important functions in their specific contexts and gave shape to a new type of interconnected infrastructure in informing and sharing public time.

1.2 Outline of Dissertation

This dissertation examines the materials for making time in four themes. Each chapter details how materiality shaped and transformed how people defined and conceived of time. The chapters focus on object-oriented case studies and situate the material practices that surrounded that type of object in its social, cultural, economic, and political contexts. Chapter one therefore opens with calendars as the most visible and everyday tool used for organizing time. The chapter argues for the concept of material infrastructures of time through the networks involved in producing and distributing calendars. In 1644, the Qing adopted a new calendar and implemented the first printed calendars for the dynasty, both invoking a historical tradition of calendar distributions and changing the actual nature of these institutions. This chapter traces the origins of these institutions for making calendars and examines how this institutional framework was supposed to operate in ideal form

[100] Rachel Rich, "'Life Will Pass Quickly for Me': Women, Clocks and Timekeeping in Nineteenth-Century France," *Gender and History* 31, no. 1 (2019): 41–59.

[101] Histories of devotion and personal practice demonstrate the transformation of time for personal purposes. Zerubavel links this to a continuum of practice from the public to the personal. Eviatar Zerubavel, "Private Time and Public Time: The Temporal Structure of Social Accessibility and Professional Commitments," *Social Forces* 58, no. 1 (1979): 38–58.

and how it operated in practice. Calendar institutions reflected the imperial vision of the Qing whether the materials of the calendar, the design, or even the language used in it. Calendars reflected status and political constituencies in the empire. By looking at different calendar regulations alongside traces left on calendars in museums, I highlight four different components for the material infrastructure of calendars throughout the Qing: *format*, *production*, *distribution*, and *use*. Finally, I conclude this chapter with an analysis of material frictions. Because calendar making became entangled with the growth of the empire, the material infrastructures and their architecture fragmented. Although new communications and transportation technologies invigorated the system, many technicians, servants, and porters continued to exercise significant agency to control how information flowed and moved across space.

While chapter one focuses exclusively on the making of official state calendars, chapter two introduces private calendar and almanac makers. This chapter argues that these private merchants transformed the market by focusing on popular demand and readability. Calendars and almanacs were printed artifacts, but the government argued that almanac making violated the state's monopoly on time information. Since private calendar making could impinge on official standards, the government initially tried to monitor and control private calendar production. Chapter two examines this connection between state and society in two sections. Part one documents the change in interpretation regarding what "private" or "pirated" calendars meant from the early to late Qing. Combining extant almanacs with archival cases of calendar and almanac printing, this section argues that the 1816 Huang San case became a turning point in permitting private sales of calendars. After this case, the government allowed almanac makers to create almanacs so long as they ensured that their books did not claim to be official calendars (although they could use calendars as sources), and they followed the imperial textbooks for new astronomy and astrology. However, these early permissions had unexpected consequences. Missionaries, for instance, used the permissive market to produce almanacs, but then relied on treaty ports to protect their publications and non-standard calendars. These new conditions created distinct challenges with how to permit calendar printing yet maintain state sovereignty.

Part two switches to South China and the various almanac makers involved in private printing of calendrical information. These almanac makers were particularly creative in their ability to navigate imperial regulations and appeal to popular audiences. Using almanacs from libraries in the United States, UK, Europe, and China, I sort South China almanac makers into

three categories: family lineages, commercial printers, and individual makers. These three groups at times collaborated and competed. As profit-motivated enterprises, almanac makers worked to distinguish themselves whether because of their specific products, transmitted secrets and techniques, or their unique combination of information they published in their almanacs. These specialty printers implemented new design strategies for reading layouts that encouraged readers to find information more quickly and efficiently in these almanacs further enhancing their popular appeal.

South China almanac makers impacted state infrastructure. But they were not alone. Chapters three and four introduce additional actors who designed new tools with the goal to reform public time. Thus, in chapter three, I use the various astronomical and time-finding tools developed by Zhang Zuonan and his close friends to explore how scholar officials connected time-finding to statecraft and local activism. Zhang Zuonan studied imperial mathematics and became a local leader in statecraft reform. He used his position first as a teacher and then as a local magistrate to popularize mathematics that could be used for public management. As a local official, he produced new instruments for measuring time and educated scholar gentry about how to use his instruments, which encompassed horizontal and vertical sundials, trigonometric tables, maps, calculation aids like logarithms and sectors, celestial globes, and more. In creating his tools, Zhang articulated a vision that I call "ritual precision". Ritual precision referred to the state's use of public performance to create moments of community engagement. These rituals were treated as precise because local leaders used sub-district level space to redefine the standards of imperial time measurement. New technologies were meant to empower local gentry and provide a model for governance.

Chapter four examines Chinese-made clocks and the significance of clockmakers in popularizing ideas about time. First, this chapter documents the practices by clockmakers for organizing and creating their clocks. Combining archival records with traces left on clocks themselves, I argue that Chinese clockmakers treated clockmaking as a type of modular practice or bricolage. They combined different pieces to reconstruct clocks as was necessary. These clockmakers also treated clocks primarily through the lens of repair. Although clockmakers did create instruments, many artisans specialized in repairing and monitoring clocks. This meant that clockmakers viewed themselves mostly as the people who tinkered with clocks rather than creators and designers in the clockmaking practice.

Nevertheless, clockmakers were important in the culture of time. Clockmakers tried to integrate mechanical visions of time within traditional contexts. Thus, clockmakers produced at least two distinct types of clocks that were meant to showcase these possibilities. These included the clocks designed to represent the hours of the night watch, and the astronomical clocks that were used to demonstrate principles of astronomical movement and educate audiences about theories of astronomy from the principles of precision horology. Rather than viewing clockmaking in China as imitation or limited in scope, I argue that Chinese clockmakers helped circulate alternative models of time through entertainment and the culture of wonder. While clocks and pocket watches remained expensive artifacts through much of the Qing dynasty, these devices generated new reflections on the meaning of time, how to organize a day, and even how to think about future prediction and concepts of fate.

To conclude the dissertation, I end with some reflections on the significance of using materiality as a methodology. The material approach to time offers a third way to explore authority as a performance and enacted process. The media for time were instruments in the sense that they augmented or indicated time information. But they were also instruments in the sense that people used them for different means. To think about the material approach to time is to recognize the role of objects in building society and the negotiated process by which these artifacts come to have a wider meaning. Similarly, the material approach to time has significance for thinking about markets and the market for time. The Qing approach toward time was to allow businesses to sell tools and instruments. This did not result in a full-fledged market of time itself. That is to say, the labor view of time remained distinct from the market in time. But it was nevertheless a related part of this process. In other words, if industrial time was founded on the transformation from concrete to abstract forms of time, the creation of a market for time in the nineteenth century already set the stage for later models that might conform to these standards. The materials for making time have an important role in modifying how we understand these cultural shifts, and they offer an intermediate step for exploring social change.

1.3 Technical Terms

Before developing my case studies, I would first like to define several key terms and concepts about time in late imperial China. These terms will be significant throughout the rest of this dissertation. They form some of the conceptual background that is necessary to understand how

actors viewed instruments and how they defined various units for measuring and talking about time. Although I will address some concepts in greater detail in later chapters, I wish to introduce general themes and concepts here.

Days, Hours, Minutes, Seconds

What were the most salient terms for describing time units in imperial China? I will refer extensively to various terms for measuring time units shorter than a day in Chinese. Historical China employed a range of terms to refer to hours. These concepts varied by context and period, and they had different connotations whenever they were used. For instance, daytime and nighttime were generally treated as the two main divisions of the day, but astronomers defined days with more precision. The day typically began at midnight, but this was not a universal practice. Here then I focus on the three commonest ways for discussing hours.[102]

The most important unit of time in Chinese was called the *shi* 時.[103] There were twelve units of *shi* for any complete day. In other words, the *shi* unit was twice the length of an hour in Western time-reckoning. In subsequent chapters, I translate this term as "double-hour" when talking about the *shi* hour in Chinese sources. Because the *shi* covered a long span of time, official time managers eventually implemented a secondary division. Each *shi* double hour was separated into two components, the first called the *chushi* 初時 and the second called the *zhengshi* 正時. By adding these units, the system doubled into a set of twenty-four cycles, which became especially useful for foreigners when they started explaining Western systems of time reckoning.

How did people count these hours? When naming *shi* hours, folks did not count numerically like in Western reckoning but instead used the fixed order of twelve earthly branches

[102] There is a long and well-established tradition on explaining Chinese units of time. Several representative works include Theophilus Siegfried Bayer, *De Horis Sinicis et Cyclo Horario Commentationes* (Typis Academiae Scientiarum, 1735), 4 Astr.u. 25, Bayerische Staatsbibliothek.; Robert Morrison, *A View of China, for Philological Purposes ; Containing a Sketch of Chinese Chronology, Geography, Government, Religion and Customs.* (Black, Parbury, and Allen, 1817).; Ludwig Ideler, "Über Die Zeitrechnung Der Chinesen," *Abhandlungen Der Königlichen Akademie Der Wissenschaften in Berlin: Philosophische, Philologische Und Historische Abhandlungen* (Berlin), 1839, 199–369.; Albert van Beek, *Beschrijving van Een Chineeschen Zonne- En Maanwijzer, Met Kompas* (WJ Kröber, 1851).; Hermann Fritsche, *On Chronology and the Construction of the Calendar* (R. Laverentz, 1886).; Alfred Chapuis, *Relations de l'horlogerie Suisse Avec La Chine: La Montre "chinoise* (Attinger frères, 1919), 1-18.

[103] I draw on the following sources for these overviews, see Needham et al., *Heavenly Clockwork*. 199-205; Silvio E. Bedini, *The Trail of Time: Time Measurement with Incense in East Asia* (Cambridge University Press, 1994). 14-22; Wilkinson, *Chinese History*. Sections 39, 40; Zhang Yantian, *Zhongguo Gu Dai Ji Shi Kao 中國古代紀時考* (Xianggang zhong he chu ban you xian gong si, 2020).

to refer to a specific double-hour. The twelve branches formed the second component of the ancient system of counting called the celestial stems and earthly branches, *ganzhi* 干支 system. This form of counting combined ten stems with twelve branches in a fixed binomial sequence that resulted in a system of sixty combinations. When and how this system emerged is debated, although it had some connection to star asterisms and to ancestral birth and death cycles.[104] Setting origin debates aside, the sexagesimal system is attested in the Shang dynasty as a method for counting days in cycles of sixty. By the end of the Shang period, the system expanded to months and eventually by the Han dynasty it could also be employed for reckoning years.[105]

Traditional hours used the set of twelve earthly branches to order hour units. These terms had a fixed sequence, meaning that when a person referred to an hour in this system, the hour had a specific length of time. For example, the first term in the sequence was *zi* 子, and this therefore corresponded to 11:00 pm to 1:00 am. The second term was *chou* 丑, and this corresponded to 1:00 am to 3:00 am. Another feature of the earthly branches was their correspondence to animal signs. They were the same symbols used in the Chinese zodiac. As a result, one could use the animal character to point back to the branch hour. Thus, the hour of the rat was also the *zi* hour, while the hour of the ox was the *chou* hour, and so on.[106]

The system of double hours was an equal hour system, meaning that the length of each hour was the same and did not change throughout the year. However, Chinese time reckoning had two additional forms of counting that were used for measuring unequal or variable time, that is

[104] Scholars have debated whether these ideas were autochthonous or imported, and how they related to writing, inscription, and more. For various views on these debates, see Léopold de Saussure, *Les Origines de l'astronomie Chinoise* (Librarie orientale et américaine Maisonneuve frères, 1930). 277-308; Joseph Needham and Ling Wang, *Science and Civilisation: Mathematics and the Sciences of the Heavens and the Earth*, vol. 3 (Cambridge University Press, 1959). 396-398; Edwin G. Pulleybank, "Prehistoric East-West Contacts Across Eurasia: Notes and Comment," *Pacific Affairs* 47, no. 4 (1974): 500–508.; Edwin G. Pulleybank, "The Chinese Cyclical Signs as Phonograms," *Journal of the American Oriental Society* 99, no. 1 (1979): 24–38.; Allen, *The Shape of the Turtle*. 33-36, 54-56; Marc Kalinowski, "Time, Space, and Orientation: Figurative Representations of the Sexagenary Cycle in Ancient and Medieval China," in *Graphics and Text in the Production of Technical Knowledge in China: The Warp and the Weft*, ed. Francesca Bray et al. (Brill, 2007). 137-168; Charles le Blanc et al., eds., "Sur l'origine Des Signes Cycliques Chinois: Quelques Implications Astronomiques et Cosmologiques," in *Approches Critiques de La Mythologie Chinoise* (University of Montreal Press, 2007).; Adam Smith, "The Chinese Sexagenary Cycle and the Ritual Foundations of the Calendar," in *Calendars and Years II: Astronomy and Time in the Ancient and Medieval World*, ed. John M. Steele (Oxbow Books, 2011).

[105] Keightley, *The Ancestral Landscape*. 37-54 ; Marc Kalinowski, "Hemerology and Prediction in the Daybooks: Ideas and Practices," in *Books of Fate and Popular Culture in Early China: The Daybook Manuscripts of the Warring States, Qin, and Han*, ed. Donald Harper and Marc Kalinowski (Brill, 2017). 160-164

[106] Wilkinson, *Chinese History*. Section 40

units that aligned with daylight and nighttime and the changing length of these times during the year. The first of these systems can be called the "notch" counting system, or the *ke* system of time reckoning. *Ke* was a smaller unit than an hour. Today, there are four *ke* in an hour, making one *ke* equal to fifteen minutes. But in the past, the system was more varied and connected to its instrumental origin. The *ke* measuring system originated in finding time with a water clock, probably the most popular method for time measurement prior to the Qing. The *ke* or the notch referred to the gradations of a ruler which was placed in the center of the pot wherein water flowed. As water filled the pot, the ruler rose and this action was used for measuring the passing of time. Throughout imperial history, however, there were different amounts used for measuring the length of the *ke*, although the total number of *ke* regardless of its denomination was equal to a set of twelve double-hours. Before the Qing calendar reforms, the most popular conversion was one hundred *ke* for the twelve hours making a *ke* in modern time units slightly larger than fourteen minutes.[107]

Notch reckoning served as an intermediary system and allowed for one to convert between the equal hour system and tracking the time of daylight. How did it work? One would count the number of *ke* that passed from the start of the day (the *zi* hour) until sunrise. Throughout the year this number would increase and decrease. If one were just using a water clock, the duration of time could be used to track events. If one wanted to know the *ke* in *shi* hours, one could then convert the ratios.

Because the *ke* system provided a smaller division of time akin to counting by quarter-hours, some astronomers combined the *shi* and *ke* together in a mixed, equal-hour counting system. To distinguish this from the general pattern of using twelve hours, it was referred to as the "small hour system" *xiaoshi* 小時. First, astronomers divided the *shi* into the *chu* and *zheng* parts. Then, they used four units of *ke* for each hour component. Hours could also be divided into smaller units of time called *fen* 分 similar to a minute. Accordingly, to refer to a time in *shi* and *ke*, one would write *wuzheng chuke* 午正初刻 to refer to exact noon. Then, for the next unit, one would write *wuzheng erke* to refer to 12:15 pm. Although this system was widely practiced in astronomical circles, and it became the method used to define Western hour reckoning, this system was highly specialized. It was almost exclusively used in referring to times of celestial events.[108]

[107] Bedini, *The Trail of Time*. 14-15; Needham et al., *Heavenly Clockwork*. 202
[108] Wilkinson, *Chinese History*. Section 40.5, 40.6.1

Nevertheless, traditional China also had another popular system of defining hours that was based explicitly on variable hours used to find time at night. In Chinese, these hours were called *geng* 更 hours, and they have usually been translated as the hours of the night's watch or civil hours. I will use these terms interchangeably throughout the dissertation to refer to this form of time reckoning at night. The system probably had origins in collective security for walled towns at night, but for our purposes, the *geng* hours were public forms of time that were managed by the local magistrate and city officials. *Geng* hours began with sunset and ended with sunrise. There were five hours during night, and one started counting with the *chugeng* 初更 until the *wugeng* 五更 or fifth hour of the night's watch.[109]

Since the hour was timed with sunrise and sunset and because there were only five hours, the length of the hour changed according to the time of the year. The hours were shorter in summer and longer in winter. They were also some of the most prominent modes of keeping time because they were made by sound and meant to be heard by large areas. The city used the drum tower or the bell tower with a large bronze bell to produce the sounds that alerted the public to the time. Different patterns of drumming and ringing related to the start or end of the watch and the respective hours in the middle of the night. While the first and last hour were based on environmental signals, in practice these hours were connected to instruments used to measure durations. The time for when an hour began was typically determined by using the notch system, which could be controlled and monitored with clepsydrae or more commonly in the Qing period incense clocks.

These three systems – the *shichen* hours, the notch system, and the *geng* hours – were the most frequently cited means of reckoning time in late imperial China (see Table Intro-1). They are not exhaustive. There were other terms used to refer to time. For instance, there was another ancient system of referring to periods of the day that was more related to visual and environmental signals.[110] One could use other descriptions to refer to periods of time too, such as talking about meals or the end of work.[111] But in general, these three arrangements were the most significant terms used for referring to time.

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[109] Bedini, *The Trail of Time*. 16; Needham et al., *Heavenly Clockwork*. 203-205; Wilkinson, *Chinese History*. Section 40.4.3

[110] Kalinowski, *"*Hemerology and Prediction in the Daybooks: Ideas and Practices.*"* 159, Table 4.9

[111] Common statements include: the time to drink a hot tea, the time to eat a bowl of rice, the time to smoke a cigarette. James Dyer Ball, *Things Chinese; or, Notes Connected with China* (Charles Scribner′s Sons, 1904). 713

Table Intro-1: Hours in Imperial China. Sources: Needham et al., Heavenly Clockwork. 200; Wilkinson, Chinese History, Table 97

Stems	Compass Points/Months/Colors	Descriptive Terms	Animal Signs	Geng hours	Approximate Time (in 24 hour count)
zi 子	North, 11th month, Black 黑	夜半, 午夜, 夜午, 子夜, 夜分, 宵分, 中夜, 夜中, 丙更	shu 鼠 rat	三更	2300 - 0100
chou 丑	North-north-east, 12th month 臘月, White 白	雞鳴, 荒雞	niu 牛 ox	四更	0100 - 0300
yin 寅	East-north-east, 1st month, Blue-green 青	平旦, 平明, 旦明, 黎明, 早旦, 日旦, 早晨, 早朝, 昧爽	hu 虎 tiger	五更	0300 - 0500
mao 卯	East, 2nd month, Blue green 青	日出, 點卯, 日上, 日生, 日始, 日晞, 旭日	tu 兔 hare		0500 - 0700
chen 辰	East-south-east, 3rd month, yellow 黃	食時, 早食, 宴食	long 龍 dragon		0700 - 0900
si 巳	South-south-east, 4th month, red 赤	隔中, 禺中, 日禺, 日禺中, 上午	she 蛇 snake		0900 - 1100
wu 午	South, 5th month, red 赤	日中, 日正, 日午, 日高, 中午, 亭午	ma 馬 horse		1100 - 1300
wei 未	South-south-west, 6th month, Blue green 青	日昳, 日側, 日昃, 日仄	yang 羊 sheep		1300 - 1500
shen 申	West-south-west, 7th month, white 白	晡時, 餔時, 日夕, 夕食	hou 猴 monkey		1500 - 1700
you 酉	West, 8th month, white 白	日入, 日沒, 日沉, 日西, 日落, 日晚, 傍晚	ji 雞 cock		1700 - 1900
xu 戌	West-north-west, 9th month, yellow 黃	黃昏, 日暮, 日曛, 曛黃	quan 犬 dog	初更	1900 - 2100
hai 亥	North-north-west, 10th month, black 黑	人定, 夤夜	zhu 豬 pig	二更	2100 - 2300

There is one final point worth mentioning about the quality of the time described by these terms. The idea of time expressed by *geng*, *shi*, and *ke* was durative. It was not a punctiliar form of time.[112] For example, although the *zi* hour corresponds to the time around midnight, it is more appropriate to refer to this double hour as the period of elapsed time between 11 pm and 1 am, rather than as exact midnight. The term could refer to a much larger span of time. Another way to approach this is with the case of the quarter hours. The quarter-hour meaning of *ke* would not have

[112] Wilkinson, *Chinese History*. Section 40.1

meant “4:15” as in the exact point at fifteen minutes past four, but rather the stretch of time from 4 to 4:15. Time phrases tracked intervals and periods. Recall that the material life of the *ke* was as a rising ruler in a flow clock. So, although the divisions were evenly made on the rulers, the unit of *ke* marked a kind of gate to the larger flow of time. This is a subtle difference in how to think about measuring units. If the minute and hour in Western time reckoning served as a marker for a specific point in time, the *shi* and *ke* in traditional Chinese time reckoning described time more like the lengths between those points.

One way to compare these forms of measurement might be the modes of epistemology that Peter Galison calls *image* versus *logic*, two traditions for constructing evidence and inference. In the case of image traditions, measurement occurs as one tries to copy the complexity and mirror it, what Galison describes as a homomorphic approach towards representation. In the case of logic traditions, measurement focuses on statistical inference and logical relations, or what he describes as a “homologous” form of representation.[113] Hence what is at stake in this case is that just as the wording for how to talk about time reflects the types of tools used to try to measure it, so too did the concept introduce a different epistemic tradition. While these two approaches had less significance for smaller units of time, they still shaped values about lateness, arrival, and precision.[114]

Seasons and the Year

Another important set of keywords to introduce is phrases for seasonality and the year. Calendars typically included several terms related to the year (i.e. *nian* 年). This is in part because the Chinese year was a combination of a solar and lunar cycles. The solar year was defined as 365 ¼ days. The lunar year was made up of twelve cycles per month (*yue* 月) which may be more technically called a lunation, for each lunation equated to approximately 29.53 days. In practice, one must use whole days. So months (in contrast to the more technical lunation) alternated between 29 and 30 days, what was called a small month *xiaoyue* 小月 and a large month *dayue* 大月 respectively.

[113] Peter Galison, *Image and Logic: A Material Culture of Microphysics* (University of Chicago Press, 1997). 19

[114] This distinction in viewing time through categories rather than through discrete markers might also be compared to the philosophical distinction between A-series and B-series time. In A-series time, time is categorized into ontologies of past, present, future. These ontologies point to a model of dynamic and flow-oriented time. But in B-series time, time is represented more through the relations of “before” and “after”. For more on these theories, see Gell, *The Anthropology of Time*. 149-155; D. H. Mellor, *Real Time II* (Routledge, 1998).

The lunar year did not correspond to the tropical year. This created a coordination problem between the two sets of cycles. To solve this, ancient astronomers developed a formula for reconciling solar and lunar years whereby they added seven extra lunations in a nineteen-year period. This amounted to an extra thirteenth month or an intercalary month (i.e. *runyue* 閏月) about every three years. In Western astronomy, this was called the Metonic cycle.[115] In Chinese astronomy, it was called the Rule cycle *zhang* 章, and it had been implemented since before the imperial era.[116]

Beyond intercalation, there were several other special features about the month that merit comment. The first is the fact that months started on the new moon, i.e. *shuori* 朔日. This idea had several consequences. First, it implies that each month pivoted around the full moon or the *manyue* 滿月. Although the size of the month alternated between 29 and 30 days, the full moon almost invariably fell on the 15th day of the month. This meant that one could identify the day of the month through quick observations on the size of the moon. Secondly, it allowed one to know when an eclipse might happen. Solar eclipses occurred during the new moon and lunar eclipses occurred during a full moon. That *shuori* corresponded to the first day of the month helped simplify and organize how to predict these eclipses which were celestial phenomena that had greater political and social significance. Thirdly, because the system linked so closely with the phases of the moon, if a day did not match an observation (i.e. the new moon occurred on the last day of the month or on the second day of the month), it demonstrated issues in calendar measurements and calculations. When there were such discrepancies, political leaders required astronomers to produce greater observation and evaluation to fix the calendar and bring the cycles back into harmony.[117]

More than just months, similar accommodations related to the determination of seasons and the start of the year (See Table Intro-2). There were four main seasons, and they were based around astronomical concepts of solstices and equinoxes. These terms corresponded to winter, spring, summer, and autumn. Starting with the early imperial period, there were additional subdivisions added to these seasons. The first set were sometimes called the periods for beginning

[115] For the Metonic cycle, see Claudius Ptolomeus, *Ptolemy's Almagest*, trans. G. J. Toomer (Gerald Duckworth & Co., 1984). 131-141; James Evans, *The History and Practice of Ancient Astronomy* (Oxford University Press, 1998). 182-188; James Evans and J. Lennart Berggren, *Geminos's Introduction to the Phenomena: A Translation and Study of a Hellenistic Survey of Astronomy* (Princeton University Press, 2007). 183-184
[116] Cullen, *Heavenly Numbers*. 39-42
[117] Compare with Cullen, *Heavenly Numbers*. 52-53

the seasons. These days were determined by using equal intervals between the winter and summer solstice to divide the season around the central pivot (the solstice or the equinox) and the starting or establishment day. This set of eight terms expanded into additional subdivisions that were called medial joints. Together these terms formed a set of twenty-four terms that divided the solar year into predetermined parts. Collectively then, these terms were called the *jieqi* or the twenty-four seasonal qi.

Table Intro-2: Table of Twenty-four Seasonal Joints. Although these terms have been translated many times, I prefer Christopher Cullen's terminology. Source: Christopher Cullen, "Calendars and Calendar Making in Qin and Han Times," 283.

Chinese	**Translation**		**Chinese**	**Translation**
冬至	Winter Solstice		夏至	Summer Solstice
小寒	Lesser Cold		小暑	Lesser Heat
大寒	Great Cold		大暑	Great Heat
立春	Beginning of Spring		立秋	Beginning of Autumn
雨水	Rain Waters		處暑	Enduring Heat
驚蟄	Awakened Insects		白露	White Dew
春分	Spring Equinox		秋分	Autumn Equinox
清明	Clear and Bright		寒露	Cold Dew
穀雨	Grain Rains		霜降	Frost Fall
立夏	Beginning of Summer		立冬	Beginning of Winter
小滿	Lesser Filling		小雪	Lesser Snow
芒種	Grain in the Ear		大雪	Great Snow

These seasonal markers helped determine the placement for the start of the year. Although in ancient China there were competing systems for when to start the year whether the winter solstice or the spring equinox, the calendar model that became the standard rule by the Han dynasty was the *Xiazheng* 夏正 calendar, a set of rules that are still used today in determining the start of the year in the Chinese calendar.[118] According to these rules, the first month of the year corresponded to the start of spring. It had a special name called the *zhengyue* 正月. In more

[118] Cullen, *Heavenly Numbers*. 65

technical language, this month started with the first new moon that occurred during the solar period for the establishment of spring. Because the lunar times shifted due to intercalary months, the first day of the solar period that started spring (i.e. *lichun* 立春) sometimes occurred after the new moon and sometimes before. But because the *zhengyue* signaled the start of spring, the next seasonal joint called *yushui* 雨水 Rain Waters always occurred at some point in the first month.[119]

These general statements should not preclude the fact that there were other methods for defining years that were less astronomically defined and more related to the use of agricultural activities and work tasks. For example, the historical text called "Monthly Ordinances" *Yueling* 月令 also described a year.[120] The Ordinances used solar and lunar information to discuss calendars, but they also mentioned star constellations and asterisms to coordinate the system with the stars.[121] Agricultural handbooks could introduce alternative rhythms. Francoise Sabban, for example, has studied recipes and food preservation as another way to identify seasons and months. The eleventh and twelfth months were often periods of rest, but the seventh and eighth months were full of activity in collecting harvest and preparing different starters for dough preparation, alcoholic beverages, and other strong preservatives.[122]

Some of the signals and activities were matched with the formal techniques used to create the twenty-four seasonal qi, and this more agriculturally influenced calendar also impacted more technical terms. For instance, solar joints corresponded to a set of star positions used to measure the year. These stars were called *zhongxing* 中星, a term that has been variously translated to mean centering stars, meridian stars, or transit stars. This list of stars was an important reference for refining and fixing measurements or verifying other moments of the year.[123]

Calendar

[119] Cullen, *Heavenly Numbers*. 67-68; Jean-Claude Martzloff, *Astronomy and Calendars: The Other Chinese Mathematics 104 BC - AD 1644* (Springer Berlin, 2016). 76-77
[120] Kaichun Dong, "A Preliminary Discussion of Chinese Agricultural Treatises in the Style of 'Monthly Ordinances' Yueling," *Journal d'agriculture Traditionnelle et de Botanique Appliquée* 28, nos. 3–4 (1981): 231–51.
[121] James Legge, *The Sacred Books of the East: The Li-Ki*, vol. 27 (Clarendon Press, 1885). 249-310
[122] Françoise Sabban, "'Follow the Seasons of the Heavens': Household Economy and the Management of Time in Sixth-century China," *Food and Foodways* 6, nos. 3–4 (1996): 334.
[123] Christopher Cullen, "Huo Rong's Observation Programme of A.D. 102 and the Han Li Solar Table," *Journal for the History of Astronomy* 38, no. 1 (2007): 75–98.; Cullen, *Heavenly Numbers*. 189-193; Pan, *Zhongguo Heng Xing Guan Ce Shi*. 13-16

Because one of the most important terms I use throughout this dissertation is "calendar", I would like to write a few words here about this choice and how I am using the concept of calendar. The Chinese term for a calendar is rich. The specific word is *li* or sometimes the combination *lipu* 曆譜. It has a range of meanings and functions.[124] In classical sources, *li* can be used as both a verb and a substantive noun. When used as a verb, *li* addresses the act of ordering or fixing in an order. That is to say that calendars imply the fixing of the heavens into a harmonious order. But order does not fully capture the richness of the term. Ordering has abstract and concrete aspects. In a concrete sense, *li* refers to a physical calendar. Because calendars are designed like a set of tables, the term is referring to the use of tables to place days into an order and system. The layout of the calendar is itself a kind of ordering, and the different types of calendar layouts illustrate different ways of placing that order on a medium like bamboo, silk, or paper. *Li* then refers to the actual artifact of the calendar and to the process in setting it up.

However, the term can be understood even more abstractly in the sense of system. Chinese calendars are systems of constants and rules. The imperial calendars, like the Quarter-remainder system, or the Qing's *Shixian li*, are based on rules, constants, and procedures.[125] They are combined to create the output of days that form the entire set of data and objects that are called the Chinese calendar. These systems changed over time with new problems and measurements and information. Most of the calendar systems were recorded in the astronomical sections of the state histories, but sometimes the procedures were passed down through lineages.[126] Some procedures were learned by internal practice and were not explicitly mentioned in training materials. They existed as techniques that were controlled by calendar making experts.[127]

What is significant then about this more abstract definition of procedure is that it could refer to different activities that were both treated as forms of ordering and calendaring. In bibliographic literature and in the institutions that formed the astronomical bureau itself, these two

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[124] For further discussion of these various translations for *li*, see Nathan Sivin, *Granting the Seasons: The Chinese Astronomical Reform of 1280, With a Study of Its Many Dimensions and a Translation of Its Records* (Springer-Verlag, 2009), 38-40; Martzloff, *Astronomy and Calendars,* 12-24; Morgan, *Astral Science in Early Imperial China*. 20-22

[125] Sivin, *Granting the Seasons*. 39, 42; Martzloff, *Astronomy and Calendars,* 241-260; Christopher Cullen, "Calendars and Calendar Making in Qin and Han Times," in *Books of Fate and Popular Culture in Early China: The Daybook Manuscripts of the Warring States, Qin, and Han*, ed. Donald Harper and Marc Kalinowski (Brill, 2017). 289-291

[126] For an overview of such systems, see Zhu Wenxin, *Li Fa Tong Zhi 曆法通志* (Shang wu yin shu guan, 1934). 31-34; Sivin, *Granting the Seasons*. 43-53

[127] Martzloff, *Astronomy and Calendars,* 28; Chang, *The Chinese Astronomical Bureau, 1620-1850*. 35-44

types of ordering were called *tianli* 天曆 and *tianwen* 天文. *Tianli* referred to the technical process of constructing a calendar. This meant the type of number crunching and calculating that allowed one to produce the physical artifacts that we call the calendar. *Tianwen*, on the other hand, literally meant the "patterns of heaven." *Tianwen* included the studies of astronomical phenomena such as eclipses and comets and other celestial signs.[128] *Tianwen* was important in establishing the types of constants used to produce the *tianli*. *Tianli* and *tianwen* were conducted by the same individuals, and the two sets of information were placed into calendars. Moreover, parts of *tianli* were based on cosmological correspondences. *Tianli* and *tianwen* complemented each other. They both focused on creating harmony and order, and they both employed mathematical procedures and systems to produce the objects called calendar. They were both a part of what we call *li* as a calendar system.[129]

These two aspects of the term *li*—its more abstract notion of procedure and its more concrete notion of calendar book—can sometimes be confusing when translating into English. Although the term *lipu* is used to refer specifically to the object of the calendar, people recorded *li* for the calendaring system and the physical calendars. Because my dissertation is particularly focused on the materiality of calendars, I emphasize the first definition of calendars, namely calendars as objects. Although I do discuss aspects of the calendar system when necessary, I am discussing calendars as artifacts in addition to the procedures that constructed the data for the calendar. This makes my approach slightly different than earlier work on calendars focused on trying to explain and reconstruct these procedures.

One reason is because this linguistic slippage overlaps with the broader point that the materiality of the calendar was directly related to the process of making it. Physical calendars were the system as most people experienced it. In addition to this point, because the system is treated as a unit contained in the physical calendar, I also break from the tradition in terms of imposing calendar system as primarily being about calendar making or the use of *tianli*. I wish to bring together aspects of what used to be identified as both *tianli* and *tianwen*. The two different traditions had historical precedents as distinct categories, but they were always related to each other. As a result, when I speak of calendaring and calendars, I treat the construction of calendar

[128] Morgan, *Astral Science in Early Imperial China*. 20; Lexian Liu, "Daybooks: A Type of Popular Hemerological Manual of the Warring States, Qin, and Han," in *Books of Fate and Popular Culture in Early China: The Daybook Manuscripts of the Warring States, Qin, and Han*, ed. Donald Harper and Marc Kalinowski (Brill, 2017). 85-86
[129] Morgan, *Astral Science in Early Imperial China*. 89-90

signs as equals to the construction of calendar constants. Although I use the terms astronomy and astrology as convenient references to refer to these different practices, I do not view them as in opposition, since this Western form of categorization would only impose new restrictions near the end of the nineteenth century.

1.4 Title and Approach

Lastly, let me briefly explain the dissertation's title, since it encapsulates the methodological commitments of this project and the kinds of actors and sources it brings into view. Material culture allows different communities to have a say in how they defined and used time. I have titled my dissertation "The Stars in Their Eyes" to capture some of this individuality and relationship to time-finding as well as to hint at my own approach that considers sensation, materiality, and experience. On the one hand, time finding can be literally described as a form of star-watching and star-gazing. This concept even had its own popular category in public discourse about time in China, the realm of star experts or *xingjia* 星家.[130] Star experts had a reputation for knowing how to read fate from the stars. But in practice, as my dissertation argues, these experts seem to have cared much more with gazing down toward shadows than looking up at the stars.

Nevertheless, I continue to use this phrase because it captures an important sentiment, namely that the purpose of finding the time was to harmonize the here and now within the deeper structures of the universe.[131] There was no single answer to that belief. Scholars and bureaucrats focused on ritual. And they even debated what those rituals were and how they were to be accomplished. Clockmakers and almanac makers created another vision, as they defended the harmony of the market for selling such tools. Common folk also wished to find the best way to support their families and their children. There were multiple theories of harmonizing with the stars. And that dynamism and diversity were central. "The Stars in Their Eyes" captures the

[130] For biographies of such figures, see Yuan Shushan, *Zhongguo Li Dai Pu Ren Zhuan 中國歷代卜人傳* (Run de shu ju, 1948).

[131] Although certain correlations in cosmology expanded during the Han dynasty, the integration of heaven and man remained an important component of traditional philosophy and intellectual culture. For more see Granet, *La Pensée Chinoise*.; Derk Bodde, *Chinese Thought, Society, and Science: The Intellectual and Social Background of Science and Technology in Pre-Modern China* (University of Hawai'i Press, 1991), esp. 97-103.; Richard Smith, *The Qing Dynasty and Traditional Chinese Culture* (Rowan and Littlefield, 2015)., 207-237; Josephine Chiu-Duke and Michael S. Duke, eds., "Between the Heavenly and the Human," in *Chinese History and Culture: Sixth Century B.C.E. to Seventeenth Century*, vol. 1, by Ying-shih Yu (Columbia University Press, 2016).

multiplicity for what knowing the time would mean. In starting with historical objects, we can begin to reconstruct these differences and various boundaries with their distinct representations and applications for how to find and use the time.

More specifically, this title gestures to an expansion for whose histories count in our narratives of science and knowledge. In calling this project the "Stars in Their Eyes", I wish to highlight the Chinese practitioners who created, circulated, represented, and defined time in their multifarious ways. In this sense, my dissertation builds upon the foundations of earlier scholars. Benjamin Elman titled his groundbreaking history of science in China as "On Their Own Terms". Elman brought natural studies and the investigation of things into the history of modern science in China. He argued that these earlier categories and approaches towards understanding nature remained a fundamental standard that defined how translation operated in creating modern science in China. In other words, by focusing on language, Elman pointed to the power of culture and its role in shaping scientific practices. Furthermore, instead of treating science as something externally pressed upon China, Elman studied the Chinese translators and scientists who were agents in this process creating new treatises, explanations, editing, and arguing for new methods of evaluating knowledge.[132]

I call my dissertation "The Stars in Their Eyes" in homage to this scholarly tradition even as I argue that material culture can open a new horizon to this field. Material culture offers an entry into a socially embedded history of knowledge. This is a study that draws on the categories and values of actors themselves.[133] These values were not universally shared. They were contested and

[132] Elman, *On Their Own Terms: Science in China 1550-1900*.

[133] I treat knowledge as a broad category of analysis. I define "knowledge" according to what my actors considered knowledge. This means that knowledge emerges from specific types of people in particular contexts, and there are multiple contexts that generate different sorts of knowledge. Knowledge might include knowledge of what, but it might also contain knowledge how and knowledge for what. One of the consequences of defining knowledge in this way is that different knowledge communities may not agree on the epistemic virtues nor the methods and tools that transform raw information into processed knowledge. In other words, one group's knowledge might be another group's superstition, non-knowledge, and even subjugated knowledge. Throughout my project, I engage with this problem by looking at the mobility of tools in context and the competing virtues and standards that defined this knowledge. I recognize that knowledge systems differentiate hierarchies and boundaries of knowledge and not all knowledge traverses those boundaries. For debates regarding the history and sociology of knowledge, see David Bloor, *Knowledge and Social Imagery* (1976; University of Chicago Press, 1991). 3-23; Peter Burke, *A Social History of Knowledge: From Gutenberg to Diderot* (Polity Press, 2000).; Francesca Bray, *"*Science, Technique, Technology: Passages between Matter and Knowledge in Imperial Chinese Agriculture,*" The British Journal for the History of Science* 41, no. 3 (2008): 319–44.; Peter Burke, *What Is the History of Knowledge?* (Polity Press, 2015).; Martin Mulsow and Lorraine Daston, *"*History of Knowledge,*"* in *Debating New Approaches to History*, ed. Marek Tamm and Peter Burke (Bloomsbury Publishing, 2018).; Suzanne Marchand, *"*How Much Knowledge Is Worth

debated. The goal of my project is not trying to recover a single, all-encompassing view. Instead, my goal is to capture the dynamic change of these ideas and their practices in their own communities by engaging with multiple forms of evidence that connected elite to vernacular and popular culture.[134] Just as the history of knowledge has pushed us to examine knowledge practices from the laboratory to workshops, to courts, and to the market, a material approach to time wrestles with time in its different contexts.[135] The materials for making time were knowledge tools as they enabled one to know, recognize, and then act on the time.[136]

The following sections, therefore, explore the materials for making time in late imperial China. These instruments formed a material infrastructure. To explore this infrastructure, I document paper tools and artifacts. I start with calendars to lay the background for understanding the most popular form of time infrastructure in everyday life.

Knowing?: An American Intellectual Historian′s Thoughts on the Geschichte Des Wissens," *Berichte Zur Wissenschaftsgeschichte / History of Science and Humanities* 42, nos. 2–3 (2019): 126–49. By paying attention to the movement of knowledge, I trace the new conditions that shaped and transformed knowledge, treating materials like "boundary objects." See Susan L. Starr and James R. Griesemer, "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley′s Museum of Vertebrate Zoology, 1907-39," *Social Studies of Science* 19, no. 3 (1989): 387–420.

[134] Federico Marcon has argued that histories of science in East Asia have followed four main paradigms: 1) "science" as primarily Western European concepts and practices that disseminated after the nineteenth century; 2) contemporary disciplines, such as geology and biology, and situating their objects in historical periods; 3) systematic corpuses of knowledge that have self-regulating knowledge about phenomena; 4) multiplicities that eventually emerged into science. Marcon argues that the history of knowledge engages more deeply with the socially embedded practices of knowledge, as it draws on the many categories used by historical actors and the different sets of knowledge systems that these communities shared. This methodology requires one to recognize the "big" and the "little" traditions of culture in order to more fully account for the process by which knowledge and its value changed over time. See Federico Marcon, "The Critical Promises of the History of Knowledge: Perspectives from East Asian Studies," *History and Theory* 59, no. 4 (2020): 19–47.

[135] Early histories of knowledge focused on academic and bureaucratic institutions. But more recent work situated knowledge in new places outside the walls of scholarly information. See, for example, Stevin Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* (1985; Princeton University Press, 2011).; Burke, *A Social History of Knowledge*.; Ann Blair, *Too Much To Know: Managing Scholarly Information before the Modern Age* (Yale University Press, 2010).; Elaine Leong, *Recipes and Everyday Knowledge: Medicine, Science, and the Household in Early Modern England* (University of Chicago Press, 2018).; Pamela H. Smith, *From Lived Experience to the Written Word: Reconstructing Practical Knowledge in the Early Modern World* (University of Chicago Press, 2022).

[136] Peter Burke defines the "tools of knowledge" as the material culture involved in the different stages of processing, gathering, and communicating knowledge. Burke, *What Is the History of Knowledge?* , 44-45.

Chapter 1 Calendars and Material Infrastructure, 1644-1912: Format, Production, Distribution, and Use

On the first day of the tenth month in 1877, the time had come to deliver calendars to the people of Guangzhou. The missionary John Gray (1823-1890) happened to be in the city on that occasion and described the scene. The governor-general along with the military and civil officials under his jurisdiction gathered at the printing office. The printery was located a little south of the main government building in the heart of the old walled city. In front of the building, under a carved pavilion made of wood, stood a table where all the calendars were arranged. Attendants lifted the table and walked to the head of the procession. The officials lined up and followed to the main courtyard in the government office. They crossed the courtyard and set it down. Once the pavilion was placed at the end of the hall, the procession lined either side of the building. Civil officials stood on the east, military on the west. Together the two groups of bureaucrats turned facing north towards the table of the calendars and candles. At this point, a ritual expert, a *lisheng* 禮生, entered the courtyard. He approached the pavilion and stepped onto the platform.[1] He walked to the table and picked up a calendar. He raised the calendar above his head and displayed it to all the officials in the courtyard. He shouted in praise of the emperor. Thereupon, the gathered officials kneeled and kowtowed in solemn recognition of the emperor's gift of the state calendar.

After the group returned to their standing positions, the state rite entered its final act. The first person to receive the calendar was the governor-general. He approached the overseer, who then handed him the small booklet. The rest of the officials stepped away from the walls towards the pavilion and queued. Each official received a new copy of the calendar in succession according to his rank. When everyone had received his copy, the official ceremony concluded. With the

[1] There have been several terms used to refer to ritual specialists. The term *lisheng* was typically an official term that referred to different forms of ritual leadership. *Lisheng* was more often used in South China. In North China, *lisheng* were also known as *yinyangsheng* 陰陽生. For more see Yonghua Liu, *Confucian Rituals and Chinese Villagers: Ritual Change and Social Transformation in a Southeastern Chinese Community, 1368-1949* (Brill, 2013). 48-62; Daniel L. Overmyer, *Local Religion in North China in the Twentieth Century: The Structure and Organization of Community Rituals and Beliefs* (Brill, 2009). 79; Stephen Jones, *In Search of the Folk Daoists in North China* (Ashgate Publishing, 2010). 13-14

ending of the ceremony and the leaders receiving their calendars, merchants and the general public could start selling and distributing calendars for the upcoming New Year.[2]

There are two features that stand out about this day in Guangzhou. First, this day marked the ritual for "granting the seasons", when the government officially published the new calendar that would define the upcoming year. On this day, whether in the capital in Beijing or in the provincial seats across the empire, government officials carried out the ceremony. The procedures dictated that in the palace, the reigning Emperor was the first to receive his calendar; but in the provinces, it was the Governor-General. The ceremony included large entourages representing both the civil and military components of the government. Much like the New Year celebrations—which depended on the dates determined by the state calendar—the Granting of the Seasons was one of the most important public events in imperial China. While living in a southern frontier like Guangzhou, John Gray's observations of the ceremony reminded him of the much larger infrastructure of the state that treated the distribution of time as a public duty.

Second, what might be even more remarkable about the ceremony was its rich sensory experience and materiality. Though called the "granting of the seasons," the ceremony gave abstract time a concrete, material form. What was granted was an actual thing: sets of printed calendars. They were small booklets and contained the important dates, months, and activities that guided government functions. Calendars were treated like imperial gifts, almost sacred in their association with the emperor. The ceremony marked the culmination of a year-long process in creating, transporting, and distributing these objects. Models arrived from Beijing, and local officials hired artisans and printers to produce copies for the distribution ceremony. Some versions of the calendar were made for officials. Others were produced for the open market. With all its physicality—the procession to the government office, the fragrance of the burning incense, the fabric of the calendar covers, even the layouts of the prints themselves—calendars were objects situated in their time and place. They incorporated the individuality of each locale, the combination of raw materials and resources, and the unique practices for how individuals treated and evaluated their calendars. Calendar printing was the most visible expression of the material infrastructure through which the Qing dynasty organized and regulated time.

[2] John Henry Gray, *China: A History of the Laws, Manners and Customs of the People*, vol. 2 (Macmillan and Company, 1878). 15-16; *Qin Ding Da Qing Hui Dian (Qianlong) 欽定大清會典* (Wu ying dian, 1764). j. 27, 2a

The granting of the seasons in Guangzhou illustrates an important tension. On the one hand, ceremonies and rituals about the calendar and imperial time reinforced the state's authority. On the other hand, the resources and media that materialized the tools that defined this authority undermined those conditions. Local conditions impacted the process. From the local ecologies that sourced the raw materials in these artifacts to the organization of labor behind its production and distribution, the artifacts were involved in the making of time. Calendars did not just reflect politics; they themselves had politics.[3]

This chapter explores this tension through the history of material infrastructure. Print calendars became the first point of contact for temporal infrastructure. Calendars were print artifacts that used graphical layouts to structure days, months, and sometimes even hours. They organized time for nearly all layers of society. I do not mean to suggest that calendars were the only media format that informed people about the time. Cities used bells, gongs, and clappers to distribute hour information to the public. Urban centers used incense clocks and water clocks to track passing units of time.[4] I will explore these objects in connection to other chapters. Calendars, however, operated at a more fundamental level. They informed how people approached other tools for tracking time. Calendars mediated how to know the time. They were the first sources people turned to, and they impacted how people designed other tools. When public officials wrote the hours on placards outside offices or rang the drums and bells to announce beginning and ending points of the day, these officials first read this information through calendars. Calendars provided the standards that defined why certain signals were given at predetermined times of the year. They contained the information that guided people to track additional signals. They allowed for individual planning as well as collective action. They established fixed reference points for users across the empire.

By understanding calendars as a communications network, the material perspective of calendars revises our understanding about the role of ritual in building community identity in late imperial China. Calendars could serve as instruments of social control, but they were also media

[3] Langdon Winner, "Do Artifacts Have Politics?," *Daedalus* 109 (1980): 121–36.

[4] Luo Zhewen, "Beijing Zhong Lou Gu Lou 北京鐘樓鼓樓," in *Jing Hua Sheng Di Shen Sha Hai 京華勝地什剎海*, by 北京什剎海研究會 Beijing (Beijing chu ban she, 1993), 139-149.; Wu Hung, "Monumentality of Time: Giant Clocks, the Drum Tower, The Clock Tower," in *Monuments and Memory, Made and Unmade*, ed. Robert S. Nelson and Margaret Olin (University of Chicago Press, 2003); Wu Hung, "Monumentality of Time: From Drum Tower to 'Hong Kong Clock,'" in *Remaking Beijing: Tiananmen Square and the Creation of a Political Space*, by Wu Hung (Reaktion Books, 2005).

artifacts which allowed for individual adaptation. Materiality was a defining feature of calendars. Textiles and decoration linked calendars to specific social positions and roles. Technologies of print required ongoing supplies of paper, wood, and ink. They facilitated specialization and organization in mobilizing workers to make these objects accessible to millions of readers. At the same time, the production of calendars required additional coordination in transport and supply. Similarly, once users had these artifacts, they could recycle, revise, transform, and refit them for new purposes. Calendars helped shape certain routines, but they did not define them.[5] Instead, when we look at calendars as interfaces within a larger public infrastructure, calendars could function both as models of state authority and as creative sites of resistance.[6]

Consequently, the following sections explore the unifying ambitions and the internal heterogeneity of the Qing time infrastructure. First, calendars reflected their institutional history. The Qing were not the first to create a time infrastructure. They built upon a variety of historical precedents and trends. But the Qing implemented this network at an unprecedented scale. Following this discussion of the historical precedents, I address the continuities and changes of the Qing infrastructure. There were four main components of this infrastructure: 1) formatting and design of state calendars; 2) the production technologies used in making calendars; 3) the logistics and distribution of the calendars throughout the empire; 4) the various uses of calendars in public and private life. These sections document how the state built a social and technical system that engaged with multiple audiences and groups.

What then were the consequences of this infrastructure? To further contextualize this issue, I conclude by looking at material frictions, the places of congestion and problems that stimulated creative engagement with state time. Although the Qing tried to create an ideal system that connected and unified different parts of the empire, material realities limited these outcomes. I describe two key forms of friction in this network: physical geography and intermediaries. These two contexts introduced fragmentation. They allowed new actors, such as merchants and ordinary

[5] Calendars indeed had ritual functions, but when we understand the materialities involved in calendars, calendars are less external artifacts exerting control over individual and communities as they are products of making and creating time. Contrast with Li, "Time as Norm."

[6] For more on the notion of interface and objects in motion, see Tim Ingold, "Being Alive to a World Without Objects," in *The Handbook of Contemporary Animism*, ed. Graham Harvey (Routledge, 2014). For similar approaches to studying selective adaptation through material culture, see Roger S. Wieck, *Time Sanctified: The Book of Hours in Medieval Art and Life* (George Braziller Inc., 1988); Kathyrn M. Rudy, *Piety in Pieces: How Medieval Readers Customized Their Manuscripts* (Open Book Publishers, 2016).; David P. Bresnahan, *Inland from Mombasa: East Africa and the Making of the Indian Ocean World* (University of California Press, 2024).

users, to transform this system to advance their own position in society and solve their own problems with tracking time.

1.1 History of Calendars in Imperial China

The Qing system of timekeeping brought together multiple technologies, physical monuments, and institutional practices that defined a material infrastructure for communicating and organizing time across the empire. The most important part of this system was the printing of the state calendar. As printing accelerated the publication of knowledge, the Qing leveraged woodblock printing to produce calendars at a scale unprecedented in Chinese imperial history. Print also meant that the organization of this infrastructure shifted over time. Whereas ancient modes of reckoning had relied primarily on environmental signals, print technology introduced new challenges in collecting materials, organization labor, and in the control of information. Going from handwritten documents to printed artifacts, Qing calendars transformed calendar infrastructure into a mass media format.[7]

This shift in raw materials and technologies occurred slowly. In this section, I outline the material histories of calendars within a longue durée of imperial history. Early empires relied on calendars, but they had to contend with difficulties in reproduction. The introduction of print technology challenged these institutional practices. During the Yuan dynasty, the government experimented with connecting government prints with the market, but the empire was short-lived. The Ming dynasty established many of the routines that would inform later Qing structures, but they focused on smaller scales. The Qing became the first dynasty to expand these distribution networks and focus closely on producing calendars for as many people in the empire as possible. These changes effectively disseminated information to broader audiences and created tighter

[7] Harold Innis has argued that there were essentially two biases in communications media: time-based and space-based. Time-based media, such as stone, clay, and parchment, were difficult to manufacture and transport but created lasting signals, whereas space-based media, such as papyrus and paper, facilitated long-distance exchange. These materialities led to organizational trade-offs. Hence, time-based societies were able to construct communication forms that allowed for longevity and continuity, but they struggled with expanding their influence outward because the media types often were bulky, difficult to transport, and fixed in place. On the other hand, societies that relied on more space-based formats like paper had greater flexibility to meet challenges across distances because their communication technologies promoted portability. Nevertheless, this also meant that standardization moved toward bureaucratic endeavors that often erased locality. Different states tried to address these issues by compensating for these biases in their media formats. For more on the relationship between the materiality of communications and political organization, see Harold A. Innis, *Empire and Communications* (University of Toronto Press, 2022).

control over the management of the system, establishing what would be the working time infrastructure employed until the end of the dynasty.

Calendars in Early Imperial China

Early empires introduced the concept of a material infrastructure for calendars. Myths and legends from the ancient period classified time distribution as a public responsibility, much like road building or flood control. Time distribution impacted stability. When the state accurately predicted astronomical events and defined the seasons, the populace viewed the state as legitimate. Ideally, this meant that the government prepared lists of dates and times for the upcoming year, and the government spread the information.[8] In practice, however, this proved difficult to achieve. While the Shang tracked calendrical information on oracle bones, historical commentaries suggest that public announcements of the time were communicated both in writing and orally. The emperor possessed a written calendar, but copies were not distributed. Regional leaders were expected to travel to the capital and receive the calendar's information in person. They then tracked lunar cycles locally and were expected to communicate the calendar's key dates and seasonal markers to the public through periodic announcements.[9]

The earliest historical practices are largely prescriptive rather than descriptive, but extant calendars starting from the Qin and Han dynasties offer more concrete evidence of actual practice. Bureaucratic records of the dynasty record multiple systems of marking and announcing time, and physical calendars found in burial sites attest to the variety of media that people used in their daily life to identify days of the year. Drums were used in the capital to announce the time and mark special occasions. Different parts of the empire also used water-clocks to track smaller units of time.[10] In addition to these instruments, administrative officials and individuals used different materials to record counts and calendars. The most common materials were bamboo and silk, but by the end of the Han dynasty, paper started to replace those media. Bamboo and silk calendars

[8] Bernhard Karlgren, "The Book of Documents," *Bulletin of the Museum of Far Eastern Antiquities* 22 (1950): 3.
[9] Daniel Patrick Morgan, *Astral Science in Early Imperial China: Observation, Sagehood, and the Individual* (Cambridge University Press, 2017), 116.
[10] Yi ke zhao meng wen wu gong zuo zhan, "Neimenggu Yi Ke Zhao Meng Fa Xian Xi Han Tong Lou 内蒙古伊克昭盟發現西漢銅漏," *Kaogu*, no. 5 (1978): 317–18.; Chen Meidong and Hua Tongxu, eds., *Zhongguo Ji Shi Yi Qi Tong Shi 中國計時儀器通史*, Vol 1: Gu dai (Anhui jiaoyu chuban she, 2011), 90-91.; Yukinobu Abe and Keith Knapp, "Upon Distinctly Hearing the Bell's Ringing, I Know I Am in the Imperial Capital: The Soundscape of Northern Wei Luoyang," *Monumenta Serica*, no. 1 (2025): 175–94.

also generated different types of interaction with the calendar. Some calendars, for instance, consisted of multiple bamboo strips bound together, while others used a single rotating strip that could be repositioned to calculate dates. Although these artifacts shared certain features, the manuscripts remained highly idiosyncratic, varying considerably depending on their regional origin and intended use.[11]

The government controlled this information with varying levels of success. There were scribes employed to create copies for distribution across the empire, but surviving calendars illustrate that local copyists made mistakes. Local copyists were not always informed of the reforms being implemented in the capital, particularly those involving astronomical recalibrations.[12] During the Wang Mang reign 王莽 (9 CE – 23 CE), the government tried to use oral communication. They dispatched emissaries to different regions to make public announcements about the calendar's key dates and the monthly transitions of the seasons.[13] These efforts at oral dissemination, however, had limited impact. Many local practices remained important. Even in the cases where the Han dynasty tried to change practices for their vassals, these groups were able to resist the imperial model.[14]

Nevertheless, woodblock printing slowly started to impact the state's ability to control time at smaller scales. Regulations and reports in the Tang make it clear that the state tried to monopolize the printing of calendars.[15] In the Tang, the state still relied extensively on manuscript practices for administration. The government continued to use hand-copying as a mode for

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[11] Li Ling, "Shi Ri, Ri Shu He Ye Shu: San Zhong Jian Bo Wen Xian de Qu Bie He Ding Ming 視日，日書和業書：三種簡帛文獻的區別和定名," *Wenwu*, no. 12 (2008): 73–80; Su Junlin, "Guan Yu 'Zhi Ri' Jian de Ming Cheng He Xing Zhi 關於'質日'簡的名稱與性質," *Hunan Daxue Yuelu Shuyuan* 24, no. 4 (2010): 17–22. Chen Kanli, "Time Notations and Methods for Timekeeping in the Liye Qin Strips," *Bamboo and Silk* 3, no. 1 (2019): 74–96. For additional details on these documents, see Donald Harper and Marc Kalinowski, eds., *Books of Fate and Popular Culture in Early China: The Daybook Manuscripts of the Warring States, Qin, and Han* (Brill, 2017).

[12] Daniel Patrick Morgan, *Astral Science in Early Imperial China: Observation, Sagehood, and the Individual* (Cambridge University Press, 2017), 100, 106, 120

[13] Daniel Patrick Morgan, *Astral Science in Early Imperial China: Observation, Sagehood, and the Individual* (Cambridge University Press, 2017), 124

[14] Alice Yao, "Politics of Time on the Southwest Frontier of China's Han Empire," *American Anthropologist* 119, no. 1 (2017): 86–103.; Daniel Patrick Morgan, *Astral Science in Early Imperial China: Observation, Sagehood, and the Individual* (Cambridge University Press, 2017), 120

[15] For more details on Tang dynasty calendars, see Susan Whitfield, "Under the Censor's Eye: Printed Almanacs and Censorship in Ninth-Century China," *British Library Journal* 24, no. 1 (1998): 4–22.; Alain Arrault, "Les Premiers Calendriers Chinois Du IIe Siècle Avant Notre Ère Au Xe Siècle," in *Les Calendriers: Leurs Enjeux Dans l'espace et Dans Le Temps : Colloque de Cerisy, Du 1er Au 8 Juillet 2000*, ed. Jacques Le Goff (Somogy, 2002); Alain Arrault and Jean-Claude Martzloff, "Calendriers," in *Divination et Société Dans La Chine Médiévale: Étude Des Manuscrits de Dunhuang de La Bibliothèque Nationale de France et de La British Library*, ed. Marc Kalinowski (Bibliothèque nationale de France, 2003).

providing calendars. This was probably because the primary audience served by calendars was the administration and its staff. However, private figures turned to woodblock printing to introduce new calendars for public audiences. Woodblock printing had emerged with the growth of Buddhism, and religious communities used it to reproduce and circulate religious calendars. But the state defined these calendars as unauthorized and banned the sale of these documents.[16]

In addition to legal changes, printing also started to impact form. As noted above, calendar manuscripts varied considerably in format and content. The government did try to control this variation through standardizing scribal practices. But calendars continued to lengthen. The content expanded to include information on auspicious day selection and divination methods. These formatting issues pushed calendar designers to create new types of layouts for displaying the information. The technology gradually shaped everyday scribal practice by introducing more standardized page layouts for organizing calendar information. Even though the Tang dynasty resisted using the woodblocks for this administrative function, the actual technology began to impact everyday practice in laying out the page to include the required information in the documents.[17]

These developments culminated in the Song dynasty, when the government moved to assert control over calendar printing with limited success. On the one hand, Song leaders came to recognize that woodblock printing could enable the wider circulation of state calendars. However, it also meant that the government tried to monopolize the process and remove private individuals from the market. The government was only moderately able to control this information (see Chapter 2). Moreover, the Song operated during a period when competition from rival states limited the territorial reach of their calendrical authority. The Song dynasty thus set the stage for the more systematic transformations in calendar infrastructure that would occur under the Yuan and Ming dynasties.[18]

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[16] Daniel Patrick Morgan, *Astral Science in Early Imperial China: Observation, Sagehood, and the Individual* (Cambridge University Press, 2017), 118-119.

[17] Arrault, "Les Premiers Calendriers Chinois Du IIe Siècle Avant Notre Ère Au Xe Siècle"; Arrault and Martzloff, "Calendriers."

[18] Whitfield, "Under the Censor's Eye," 15; Alain Arrault and Jean-Claude Martzloff, "Calendriers," in *Divination et Société Dans La Chine Médiévale: Étude Des Manuscrits de Dunhuang de La Bibliothèque Nationale de France et de La British Library*, ed. Marc Kalinowski (Bibliothèque nationale de France, 2003), 94.; Alain Arrault, "Les Premiers Calendriers Chinois Du IIe Siècle Avant Notre Ère Au Xe Siècle," in *Les Calendriers: Leurs Enjeux Dans l'espace et Dans Le Temps : Colloque de Cerisy, Du 1er Au 8 Juillet 2000*, ed. Jacques Le Goff (Somogy, 2002), 182.

Infrastructure and Local Control: Yuan and Ming

While the Song dynasty was the first empire to recognize the potential of woodblock printing for calendar distribution, it was the Yuan dynasty that established the model for a new state time infrastructure. First, instead of viewing printing as inimical to the state, the Mongols treated time information as a *public good* and a source of *revenue*. This was a key conceptual shift. The leadership viewed calendars as a business, not simply as a form of political legitimacy. Hence, they subsidized calendar printing and taxed the sale of calendars, a taxation strategy that helped fund the printing of paper money.[19]

To manage all of this, the Mongols established a new office called the Taishi yuan 太史院. It maintained a central office in the capital and stationed representatives in each province.[20] The office printed large and small calendars. They also hired translators to create multilingual versions. Official sources mention both Chinese and Islamic calendars, but there are also fragments in Mongolian. These fragments contain references to the Taishi yuan, which has led scholars to suggest that the Mongolian calendars were likewise official publications.[21] The size of this industry was extraordinary, if we trust the official statistics. According to the *History of the Yuan* 元史, in the year 1328-1329, the state printed more than 550,000 calendars for the capital region alone. For the provinces, they printed more than 2.5 million.[22] Combined, these figures total more than 3 million calendars. This does not account for distributions to other Mongol rulers. Mongol calendar printing constituted one of the largest printing enterprises in the preindustrial world.[23]

The Mongols also added a new human element to the infrastructure. They not only focused on the distribution of the physical calendars, but they also created a system for transmitting calendar-making skills. The Mongols famously sought people with technical skills. This policy of

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[19] Herbert Franz Schurmann, *Economic Structure of the Yuan Dynasty: Translation of Chapters 93 and 94 of the Yuan Shih* (Harvard University Press, 1967), 239.

[20] Ho Kai-Lung, "The Political Power and the Mongolian Translation of the Chinese Calendar During the Yuan Dynasty," *Central Asiatic Journal* 50, no. 1 (2006): 63.

[21] Herbert Franke, *Mittelmongolische Kalenderfragmente Aus Turfan* (Verlag der Bayerischen Akademie der Wissenschaften, 1964); Herbert Franz Schurmann, *Economic Structure of the Yuan Dynasty: Translation of Chapters 93 and 94 of the Yuan Shih* (Harvard University Press, 1967), 239; Ho Kai-Lung, "The Political Power and the Mongolian Translation of the Chinese Calendar During the Yuan Dynasty," *Central Asiatic Journal* 50, no. 1 (2006): 63.

[22] Herbert Franz Schurmann, *Economic Structure of the Yuan Dynasty: Translation of Chapters 93 and 94 of the Yuan Shih* (Harvard University Press, 1967), 239

[23] For population data on the Yuan, see John D. Durand, "The Population Statistics of China, A.D. 2-1953," *Population Studies* 13, no. 3 (1960): 228-230.; Robert M. Hartwell, "Demographic, Political, and Social Transformations of China, 750-1550," *Harvard Journal of Asiatic Studies* 42, no. 2 (1982): 365–442.

recruiting technical experts included astronomers and others with expertise in reading and interpreting celestial signs. Under the new registration system, the Mongols cultivated local networks of specialists who could interpret calendrical methods and assist local governments in conducting time-related rituals. Those trained under this system received licenses to practice their craft. They were called *yinyang* officials and were set up throughout the entire empire. They helped report and organize the local times for state rituals, and in return, the state constructed academies dedicated to the teaching of calendar-making, divination, and ritual management. These academies were typically situated near central watchtowers and other government complexes. They were responsible for announcing the civil hours and coordinating the ringing of bells. These schools also taught state astrology and served as centralized networks for training the officials responsible for managing timekeeping at the local level.[24]

The rise of these local collaborations and standardizations of personnel correlated with additional documents used in administrative material culture, the so-called *paiza*/*paizi* 牌子 permits. Although there were precedents for such permission slips, the Mongols used these bureaucratic documents strategically. They were made from different raw materials, i.e. wood, gold, or silver, to signify the status of the bearer and the nature of the authorization granted. The most famous of these permits were related to the pony express system, but there were also *paiza* for controlling movement at night. These travel restrictions were enforced according to the timing of local bells, which marked the beginning of the variable night hours. After the third mark of the first *geng* hour, local authorities prohibited travel unless the traveler carried a valid permit. There were exceptions, such as in the case of a medical emergency or illness. But generally, only people carrying a permit were allowed to move about during these hours. The permits included

[24] For additional sources on these offices, see Elizabeth Endicott-West, "Notes on Shamans, Fortune-Tellers, and Yin-Yang Practitioners and Civil Administration in Yuan China," in *The Mongol Empire and Its Legacy*, ed. Reuven Amitai-Preiss and Daniel Patrick Morgan (Brill, 1999); Ye Xinmin, "Yuan Dai Yin Yang Xue Chu Tan 元代陰陽學初探," *Menggu Yan Jiu* 6 (2000): 49–57; Chen Gaohua, "Yuan Dai de Di Fang Guan Xue 元代的地方官學," in *Yuan Shi Yan Jiu Xin Lun 元史研究新論*, ed. Chen Gaohua (Shanghai she hui ke xue yuan chu ban she, 2005); Zhang Tongzhu, "Lun Yuan Chao Zhi Guan Xi Tong Zhong de Yin Yang Xue Ji Gou 論元朝職官系統中的陰陽學機構," *Lilun Xuekan*, 2014, 111–15; Li Yuanhua, "Yuan Dai Yin Yang Xue Jiao Xue Nei Rong Kao Bian 元代陰陽學教學內容考辨," in *Ji Nian Jiao Yu Shi Yan Jiu Chuang Kan Er Shi Zhou Nian Lun Wen Ji 紀念教育史研究創刊二十周年論文集* (Beijing, 2009); Zhao Xiaoming, "Cong Hei Shui Cheng Wen Xian Kan Yuan Dai de Yin Yang Xue Jiao Yu 從黑水城文獻看元代的陰陽學教育," *Heng Yang Shi Fan Xue Yuan Xue Bao*, no. 1 (2016): 108–12; Qiao Yang, "Like Stars in the Sky: Networks of Astronomers in Mongol Eurasia," *Journal of the Economic and Social History of the Orient* 62, nos. 2–3 (2019): 388–427; Qiao Yang, "Lesser Elite in Crisis: Family Strategies of Divination (Yinyang) School Instructors in the Yuan–Ming Transition," *Journal of the Royal Asiatic Society* 35, no. 1 (2025): 97–109.

multilingual inscriptions that allowed officials from different linguistic backgrounds to verify and interpret them (see Figure 1-1), and the permits were even designed with tracking numbers and indexes to identify permission and the holder.[25]



Figure 1-1: Paiza or permit for traveling at night. The paiza is written in four scripts: Chinese, Persian, Square script, and Classical Mongolian. The top of the paiza is covered in a mythical bird-like figure called the garuda. On the outer ring, there is a set of numbers which were likely invoice numbers to track the permits. Source: National Museum of Mongolia

While traveling through the Yuan empire, Marco Polo described the security and timekeeping functions of the night watch posts.

> Each guard is provided with a hollow instrument of wood and with a metal basin, and with a time-keeper to enable them to know the hour of the day or night. And so when one hour of the night is past the sentry strikes one on the wooden instrument and on the basin, so that the whole quarter of the city is made aware that one hour of the night is gone. At the second hour he gives two strokes, and so on, keeping always wide awake and on the look out. In the morning again, from the sunrise, they begin to count anew, and strike one hour as they did in the night and so on hour after hour.[26]

[25] Baohai Dang, "The Paizi of the Mongol Empire," *Zentralasiatische Studien* 31 (2001): 43-45.
[26] Henry Yule, *The Book of Sir Marco Polo*, vol. 2 (J. Murray, 1875): 171.

This account notes that the watch posts were also responsible for marking the hours during the day. Polo's emphasis on regulating nighttime movement and coordinating security reflects a broader pattern of militarized control over the night hours that characterized Yuan urban governance.

Although the full extent of these practices across the Mongol empire awaits further study, this new infrastructural vision had a direct impact on Ming administrative organization. The early Ming was smaller than the Mongol Empire, but they combined the state and local infrastructures to bring provincial seats under tighter centralized control. Following the precedent of earlier dynasties, the Ming established a calendar department responsible for distributing the state calendar each year on the first day of the tenth month. The calendar ceremony served as the formal occasion for distributing the calendar to court officials. At the same time, the court astronomers also prepared additional models and copies that were sent to local provinces and districts. The provincial government was then responsible for distributing calendars to the rest of the population.[27]

The Ming particularly emphasized the construction of new materials to control local time. The Ming repaired existing bell and drum towers and commissioned more new ones than any previous dynasty. Designed for each provincial seat, these towers served as fixed nodes within the logistics networks used to coordinate military mobilization.[28] The towers were central repositories for the tools of standardization. The bell tower also housed the standard rulers used in construction and the official measurement vessels used for grain.

This included human resources. The Ming maintained the network of yinyang officials first established under Mongol rule. Exceptional candidates were selected to study in the capital, while families with hereditary expertise continued to support local officials and staff the timekeeping

[27] For more detail on the functions of the Ming Astronomical Bureau and its role in time service, see Thatcher E. Deane, "The Chinese Imperial Astronomical Bureau: Form and Function of the Ming Dynasty 'Qintianjian' from 1365 to 1627" (Phd Dissertation, University of Washington, 1989), 305-352.

[28] For more detail on these networks, see Timothy Brook, "Communications and Commerce," in *The Cambridge History of China: The Ming Dynasty, Part 2: 1368–1644*, vol. 8, ed. Denis Twitchett and Frederick W. Mote (Cambridge University Press, 1998).; Lane J. Harris, "The 'Arteries and Veins' of the Imperial Body: The Nature of the Relay and Post Station Systems in the Ming Dynasty, 1368–1644," *Journal of Early Modern History* 19, no. 4 (2015): 287–310; Lane J. Harris, "Into the Frontier: The Relay System and the Ming Empire in the Borderlands, 1368-1449," *Ming Studies* 72 (2015): 3–23; Chelsea Zi Wang, "Dilemmas of Empire: Movement, Communication, and Information Management in Ming China, 1368-1644" (Phd Dissertation, Columbia University, 2017); Chelsea Zi Wang, "More Haste, Less Speed: Sources of Friction in the Ming Postal System," *Late Imperial China* 40, no. 2 (2019): 89–140.

networks of their cities.[29] The Ming also tightened control in other ways. They instituted two new forms of sub-district administration called the *baojia* 保甲 and *lijia* 里甲.[30] The *baojia* units were mutual defense forces under a single headman who reported to the local magistrate. These forces were also responsible for time reporting. As with the earlier Yuan system, these security forces announced the night hours in cities and villages, alerting communities to the passage of time while also warning neighborhoods of fires or other dangers.[31]

Creating a Qing Infrastructure

Woodblock printing transformed how the state communicated time to local communities across the empire. Yet this infrastructure did not depend on printing alone. It also relied on provincial institutions, local materials, ritual practices, and Inner Asian traditions of time reckoning. These elements produced a Qing infrastructure that maintained historical continuities while adding new features from the Manchus' distinct approaches to time. Before the Manchus crossed the southern passes, they were already experimenting with ways to reconcile competing systems for measuring and displaying time. After they entered Beijing in 1644 and defeated Li Zicheng's forces, the Qing adopted a calendar reform based on Western astronomical methods. This reform offered a third means of distinguishing the Qing from the Ming: it introduced new measures, institutions, and technical specialists who helped create an alternative system of calendrical authority. Although this process was not linear, it gave rise to a distinct set of concerns that shaped the Qing material infrastructure of timekeeping.

[29] Shen Jiandong, "Yuan Ming Yin Yang Xue Zhi Du Chu Tan 元明陰陽學制度初探," *Da Lu Za Zhi* 79, no. 6 (1989): 21–30; Yin Minzhi, "Ming Dai de Yin Yang Sheng Yu Yin Yang Hu 明代的陰陽生與陰陽戶," *Shi Xue Yue Kan*, no. 3 (2019): 39–48.

[30] Jaeyoon Song, "Redefining Good Government: Shifting Paradigms in Song Dynasty (960-1279) Discourse on 'Fengjian,'" *T'oung Pao* 97, nos. 4–5 (2011): 301–43; Liao Yin and Yangyang Du, "Moving Towards Refinement: Rural Organizations and Rural Governance in the Song Dynasty," *Frontiers of History in China* 18, no. 4 (2023): 470–95.

[31] For more on the *baojia* and *lijia* structures during the Ming, see Timothy Brook, "The Spatial Structure of Ming Local Administration," *Late Imperial China* 6, no. 1 (1985): 1–55; Kandice Hauf, "The Community Covenant in Sixteenth Century Ji'an Prefecture, Jiangxi," *Late Imperial China* 17, no. 2 (1996): 1–50; Martin Heijdra, "The Socio-Economic Development of Rural China during the Ming," in *The Cambridge History of China: The Ming Dynasty, Part 2: 1368–1644*, vol. 8, ed. Denis Twitchett and Frederick W. Mote (Cambridge University Press, 1998).

Pre-1644: Inner Asian Material Practices

The Manchus, whose ancestors were linked to the Jurchen Jin dynasty 金 (1115–1234), used systems of timekeeping shaped by both Inner Asian exchange and local ecological practices. For instance, steppe peoples developed vocabularies of time reckoning tied to environmental cues and local landscapes.[32] They also preserved calendrical traditions that were adapted to specific social, ritual, and ecological contexts. One of the most ancient was the Turkic animal cycle.[33] By the sixteenth century, Buddhism also had a significant impact. The introduction of Tibetan Buddhism created monastic institutions dedicated to tracking time as well as the use of the Tibetan calendar. Accordingly, there were at least five different calendar systems which shaped time recording among Northeast Asian and Inner Asian peoples (see Table 1-1).[34]

Table 1-1: Table of Year Count Formulas. Adapted from Elverskog, "Mongol Time Enters the Qing World," 161

System	Formula	Example
Mongolian	color (gendered) + animal	yellow rat
Uygur	stem + animal	*bing* snake
Tibetan	element + animal	wood horse
Chinese	stem + branch or regnal name and number	ji si / Tianqi 10
Bureaucratic	element + animal + regnal name and number	Daoguang 10 metal pig

These practices for time can be understood as alternative models for organizing time. For instance, different calendar systems circulated within distinct social and status contexts. The Jurchens maintained multiple systems of calendars because each system served a different purpose

[32] Compare with Volker Rybatzki, "Names of the Months in Middle Mongol," in *Altaica Budapestinensia Mmii: Proceedings of the 45th Permanent International Altaistic Conference (PIAC) Budapest Hungary, June 23-28, 2002*, ed. Alice Sarkozi and Atilla Rakos (Hungarian Academy of Sciences, 2002). ; Johan Elverskog, "Mongol Time Enters a Qing World," in *Time, Temporality, and Imperial Transition: East Asia from Ming to Qing*, 1st ed., ed. Lynn A. Struve, Asian Interactions and Comparisons ; 8 (University of Hawaii Press, 2005), 161. ; Louis Bazin, *Les Systemes Chronologiques Dans Le Monde Turc Ancien* (Editions du CNRS, 1991), 77-87.

[33] For more, see Louis Bazin, *Les Systemes Chronologiques Dans Le Monde Turc Ancien* (Editions du CNRS, 1991), Chapter 3.

[34] Johan Elverskog, "Mongol Time Enters a Qing World," in *Time, Temporality, and Imperial Transition: East Asia from Ming to Qing*, 1st ed., ed. Lynn A. Struve, Asian Interactions and Comparisons ; 8 (University of Hawaii Press, 2005), 160-161. For an extended treatment of different calendar systems in Mongolian, their history and sources, see Brian G. Baumann, "Divine Knowledge: Buddhist Mathematics According to Mostaert's Manual of Mongolian Astrology and Divination" (Phd Dissertation, Indiana University, 2005), Introduction.

depending on the situation. Native terms were linked to lunations, whereas the animal cycle was used for astrological calculation.[35] The Mongols also practiced this separation applying some systems for astrology with others used to measure month cycles.

More than just function, calendar systems also had material associations. During the Mongol period, calendars were largely dependent on paper. But by the sixteenth century, many calendars were recorded on different media. Some calendar artifacts were related to stone monuments, and others were based on local materials like birch-bark. These birch bark calendars were significant raw materials used for recording sutras, transactions, and transmitting calendar information. These elements helped form a distinct appearance to calendars that were from the steppe compared to calendars that were circulating from the Ming empire.[36]

This connection between local resources and calendars impacted the early Qing. One of the best examples of this type of relationship comes from the Nanai people. The Nanai lived in the far northeast, and they preserved some of the older traditions of Jurchen calendar-making, something that the Qing strategically tried to maintain over time as well. The Nanai culture linguistic features with Jurchen and Manchu communities. Like the Jurchens, they distinguished between two dating systems: one used for village labor and another used for astrology. They had both Chinese lunar calendars and local calendars based on animal migrations. They defined the year in relationship to the first salmon migrations. Then, when they tracked months and days, they constructed a special birch-bark calculator (see Figure 1-2). The calculator had two lines, an upper line used for months, and a lower line used for days. Each month consisted of either 29 or 30 days. They used different sizes of strips to mark the passing of time for months versus days. By assigning different materials to different temporal contexts, they maintained multiple layers of temporality.[37]

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[35] Alexander Vovin, "Some Thoughts on the Origins of the Old Turkic 12-Year Animal Cycle," *Central Asiatic Journal* 48, no. 1 (2004): 119-121. This dichotomy between one calendar that is used for agriculture and organization compared to a second calendar that is used for ritual and divination reflects a similar theme espoused by Clifford Geertz in discussing Balinese schedules of time. Clifford Geertz, *The Interpretation of Cultures: Selected Essays* (Basic Books, 1973). 360-411

[36] Ho Kai-Lung, "Spread and Preservation of Chinese Divination in Mongolian, 14th–17th Centuries: The Documents of Dunhuang, Turfan, Qara Qota and Xarbuxyn Balgas," *Central Asiatic Journal* 56 (2013 2012): 133–53.; Elisabetta Chiodo, ed., *The Mongolian Manuscripts on Birch Bark from Xarbuxyn Balgas in the Collection of the Mongolian Academy of Sciences*, vol. 1 (Harrassowitz, 2000), 206-209.

[37] Ling Chunsheng, ed., *Songhua Jiang Xia You de He Zhe Zu 松花江下游的赫哲族*, Jin Xian Dai Zhongguo Bian Jiang Jie Wu Zi Liao 近現代中國邊疆界務資料 12 (1934; Fu chi shu yuan chu ban you xian gong si, 2007), 199-200, 5968-5969, 208, 5979.

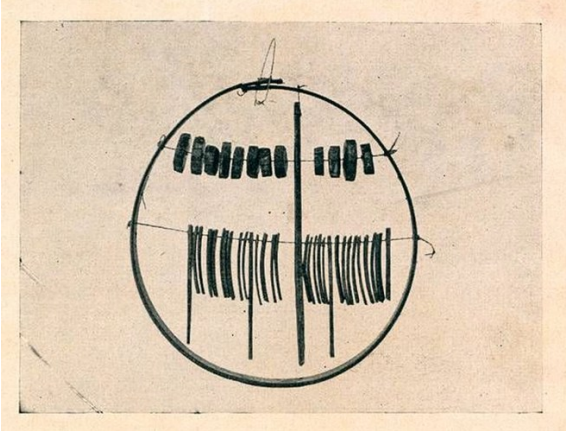

Figure 1-2: Calendar tallies from the Nanai culture. Source: Ling Chunsheng, ed., Songhua Jiang Xia You de He Zhe Zu, Vol 12, 201, fig. 330.

As the Qing began to form a state, they remained conscious of these multiple levels of temporality. Nurhaci incorporated local temporal practices into New Year rituals. After consolidating his power against rival clans and his own brother, he established the Later Jin 金 khanate in 1616. In the early years of his reign, he initiated the *tangse* ritual as a special ceremony performed during the New Year festival. Formally recognized in 1622, these rituals belonged to the shamanic tradition of the Jurchens. The ritual materialized a new social order by linking participation to marriage alliances and other political relationships under Nurhaci. The ruler led the procession to the hall, and then the ruler conducted additional honors for the ancestors in another building. The ceremony defined the beginning of the year. These rituals enacted local materialities. But they were also significant in the formation of a new identity under the Qing. Although the Jianzhou Jurchens largely followed the Ming calendar, these rituals translated political autonomy into material and ceremonial practice.[38]

These ceremonies remained significant with the formal recognition of a new empire. In 1635, Hong Taiji 皇太極 (1592-1643) changed the name from the Later Jin and transformed the khanate into the Qing dynasty. He continued to use the *tangse* New Year's Ceremony as a form of political ordering. The Confucian ministers who joined his court helped established a Board of Rites for the dynasty. They recommended that he discard these ceremonies. Hong Taiji, however,

[38] Macabe Keliher, *The Board of Rites and the Making of Qing China* (University of California Press, 2019), 45-64.; Julia Manchu Wu, "The New Year Tangse Ceremony and the Making of Qing Rule," *Late Imperial China* 45, no. 2 (2024): 113–52.

refused.[39] Instead, these rituals remained an important reflection of the multitribal alliance that gave authority to the ruler. They recognized northern traditions as being on par and just as significant to the Confucian rituals. The ceremony did however become more structured and ordered as Hong Taiji strengthened his leadership. Beginning in 1632, Hong Taiji incorporated formal positions and ranks into the ceremony, using ritual hierarchy to marginalize rivals. Hong himself became the central ritual overseer while the relatives and allies who were beneath him were relegated to ranks of distinction.[40] These practices not only ordered the ritual procession but also started to reflect access to resources in the new polity.

In 1638, Hong Taiji expanded this ritual order through the first recorded publication of a Qing dynastic calendar.[41] Although the Qing had used regnal titles to mark dates for several years, the third year of Hong Taiji's dynasty provides the first recorded instance of a formal calendar ceremony and the distribution of calendrical materials to multiple constituencies. The chosen date was the traditional day for calendar distribution in the Chinese ritual calendar: the first day of the tenth lunar month. The calendar was prepared by the newly established Board of Rites and was placed on the platform by the managing directors of the Board who were high-ranking Manchu elites.

There were at least two types of calendars: one for the emperor himself, called the *shangli* 上曆 and others distributed to officials and relatives. During the ceremony, the ministers placed one of the calendars in the state archive. The people who were gathered in the courtyard performed the kowtow with three genuflections and nine head touches in respect of the calendar, while the overseers shouted that this was the calendar for the fourth year of Chongde 崇德 (the regnal title for the emperor). The emperor received his copies which were wrapped in yellow covers. Then, after the emperor, the princes of the blood and other relatives received three sheets. The Mongol princes, Korean emissaries, and the three military banners (i.e. Manchu, Mongol, and Chinese) all received one copy of this new publication. On this occasion, because the Qing had just recently

[39] Julia Manchu Wu, "The New Year Tangse Ceremony and the Making of Qing Rule," *Late Imperial China* 45, no. 2 (2024): 124.
[40] Macabe Keliher, *The Board of Rites and the Making of Qing China* (University of California Press, 2019), 49-50.
[41] For additional details on the early calendar printing before 1644, see Wang Xiaohu, "Qing Ru Guan Qian Ban Li Shou Shi Shi Shi Kao 清入关前颁历授时史事考," *Shi Xue Yue Kan*, no. 4 (2018): 72–80.

defeated a Ming garrison in Liaodong, they also gave one last copy of the new calendar to the defeated captain Shen Zhixiang 沈志祥 (? - 1648).[42]

How were these calendars made and what did they look like? We know little about the shape and layout of these calendars. But the Korean response to these calendars in 1637 to 1639 explain some of the ways in which calendar design encoded power. As a calendar system, the calendars relied on the Ming techniques, the *Datong li* 大統曆. But the names and titles on the pages of the calendar were different. The Manchus required that the new calendars replace the Ming titles with the title of Chongde. In 1637, after the Joseon court surrendered to the Manchus, Hong Taiji required that they send their calendars for the year 1638 to the border for inspection. Because the Koreans had already printed the calendars for the coming year in the Ming format, they were uncertain how to respond. After some discussion, they simply printed several new copies of the calendar with the title for Chongde and then shipped them to the Manchus.[43]

In the following year, the Joseon court responded to the new distribution of calendars from Liaodong with a new policy. The Joseon decided to create a system of two calendars that would be sent to different regions. For the northern borders, the Joseon court followed the Qing model. They printed the calendars with the Qing regnal title, and they deleted the final pages which had traditionally served as the sources for showing imperial lineages.[44] Those lineage pages were important for organizing burial rites. Although the new calendars deleted the lineage pages, the Korean state continued to hold burial rites and official ceremonies supporting the Ming.[45]

In order to present some continuity, the Koreans therefore produced a second calendar for southern provinces. For this calendar, the Joseon court decided not to print the Qing regnal title at all and only include the *ganzhi* terms for the year. If a Qing official questioned the frontiersmen about why the new calendar did not list the imperial lineages, the officials were supposed to say that it was because of the debates over which titles to use. If Japanese visitors to the south asked

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[42] CD 3.10.1, Zhongguo di yi li shi dang an guan, ed., *Qing Chu Nei Guo Shi Yuan Man Wen Dang an Yi Bian 清初內國史院滿文檔案譯編*, vol. 1 (Guang ming ri bao chu ban she, 1989), 375.

[43] Kwon Soo Park, "Calendar Publishing and Local Science in Chosŏn Korea," in *Science and Confucian Statecraft in East Asia*, ed. Francesca Bray and Jongtae Lim (Brill, 2019), 134-136.

[44] Kwon Soo Park, "Calendar Publishing and Local Science in Chosŏn Korea," in *Science and Confucian Statecraft in East Asia*, ed. Francesca Bray and Jongtae Lim (Brill, 2019), 136.

[45] Seung B. Kye, "The Altar of Great Gratitude: A Korean Memory of Ming China under Manchu Dominance, 1704–1894," *Journal of Korean Religions* 5, no. 2 (2014); Seunghyun Han, "The Mangbaerye Examinations: Ming Loyalist Court Rituals and Royal Authority in Eighteenth- and Nineteenth-Century Chosŏn," *Journal of Korean Studies* 27, no. 1 (2022): 3–36.

why the Koreans had deleted regnal titles from the calendars, the officials were supposed to say that it was because of paper supply problems due to the war with the Qing. While the royal family had complete calendars, the private calendars for everyday use were made to look simpler.[46]

From the earliest stages of state formation, the Qing sought to build a new material infrastructure around the calendar. This point can be taken even further when we compare the informational strategies of the Qing. The early state sought larger supplies of paper to improve recordkeeping and move beyond the birch-bark practices that had earlier shaped its archival preservation. There were significant paper shortages in the Nurhaci period. Qing expansion into Liaodong and its new relationship with Korea also increased access to paper as an administrative medium.[47] Material form mattered because the quality, format, and design of calendars reflected political status.

Post-1644: Shixian li 時憲曆

Before 1644, the Qing had already undertaken several efforts to organize time. They interacted with competing groups and multiple systems of time reckoning. They also used material forms—ritual objects, printed calendars, paper, and archival practices—to organize this emerging infrastructure. When the Manchus entered Beijing, they took over the Ming infrastructure and gained access to resources that expanded their reforms. At this point, the Qing had the opportunity to alter the calendrical system and implement new changes.

Within the first month of the Qing takeover in Beijing, Adam Schall von Bell (1591-1666) submitted a petition offering his service. He presented a completed calendar reform as a tool that could help the Qing legitimate their rule. Von Bell happened to be in the right place at the right time. For the past two decades, the missionaries had been involved in revising the *Datong li*. They had completed the reform by 1634 in a collectanea called the *Chongzhen lishu* 崇禎曆書. But there were significant delays in using that model. The Ming Chongzhen emperor officially accepted the calendar only in 1643, by which point the political situation had deteriorated. Li Zicheng had already started his rebellion, and the Manchus had also achieved success on the northern frontier.

[46] Kwon Soo Park, "Calendar Publishing and Local Science in Chosŏn Korea," in *Science and Confucian Statecraft in East Asia*, ed. Francesca Bray and Jongtae Lim (Brill, 2019), 136-137.
[47] Devin Fitzgerald, "Research Note: Between Paper and Wood, or the Manchu Invention of the Dang'an," *Saksaha: A Journal of Manchu Studies* 13 (2015): 75–80.

Before the 1644 calendar could be completed and published, Li Zicheng entered the capital, and the Chongzhen emperor committed suicide.[48] Around the same time, most missionaries fled Beijing for other cities. Von Bell remained behind to protect the various instruments and property that the Jesuits held in the capital.[49]

Once the Manchus had defeated the rebels and calmed the city, multiple groups sought Qing patronage by submitting calendars. Schall made his case based on the calendar reforms and his expertise in various practical sciences. He explained that he had been working on the calendar reform for the Chongzhen emperor, and he offered his skills to help the Manchus set up a new calendar.[50] Because there were multiple petitions for imperial sponsorship, the Manchus implemented a trial based on models for an upcoming eclipse. Schall's predictions proved to be the most accurate compared to rivals. Therefore, the regent Dorgon granted Schall's request. Because Schall had already prepared much of the material, he was able to submit the new calendar by the tenth month. He was then promoted to become the Director of the Astronomical Bureau.[51]

Although von Bell had won the trial, the new calendar remained controversial. For example, other missionaries criticized von Bell for using the conflict to gain a government position and engage in judicial astrology.[52] But the most significant debate occurred in the 1664 calendar crisis. During the calendar crisis, several critics from both inside and outside of the Astronomical Bureau lodged complaints against Schall. He was subsequently removed from office. In the aftermath, the Qing switched to the older system of producing dates and times. Although Schall died during this period, the situation changed again in 1668. The young Kangxi Emperor commissioned several public tests between Ferdinand Verbiest (1623-1688) and Yang Guangxian 楊光先 (1597–1669) to test the calendar systems again. The tests favored Verbiest, who took over

[48] For an overview of the *Chongzhen lishu*, see Keizo Hashimoto, *Hsu Kuang-Ch'i and Astronomical Reform: The Process of the Chinese Acceptance of Western Astronomy, 1629-1635* (Kansai University Press, 1988).; Ping-Yi Chu, "Archiving Knowledge: A Life History of the Chongzhen Lishu (Calendrical Treatises of the Chongzhen Reign)," *Extrême-Orient Extrême-Occident* 6 (2007): 159–84; Yunli Shi and Chu Longfei, eds., *Chongzhen Li Shu He Jiao 崇禎曆書合校*, 2 vols. (Zhongguo kexue jishu daxue chuban she, 2017). For the events of the rebellion and transition, see Frederic Wakeman, Jr., *The Great Enterprise: The Manchu Reconstruction of Imperial Order in Seventeenth-Century China*, vol. 1 (University of California Press, 1985), 225-318.

[49] Catherine Jami, *The Emperor's New Mathematics: Western Learning and Imperial Authority during the Kangxi Reign (1662-1722)* (Oxford University Press, 2012), 36.

[50] QSL SZ 1.6.26, j. 5, 23b-24a

[51] Catherine Jami, *The Emperor's New Mathematics: Western Learning and Imperial Authority during the Kangxi Reign (1662-1722)* (Oxford University Press, 2012), 36-37.

[52] Catherine Jami, *The Emperor's New Mathematics: Western Learning and Imperial Authority during the Kangxi Reign (1662-1722)* (Oxford University Press, 2012), 38-41.

the directorship. From this point onward, the Qing maintained the *Shixian li* as the fundamental system for measuring hours, days, months, and years.[53]

The publication of a new calendar integrated the various social and material networks about time measurement. This infrastructure was not created from scratch. It combined Ming communication and logistical structures with Qing expansion into new territories across Eurasia. The system also preserved older connections among calendrical authority, ritual practice, and the regulation of local time. During the Qing, *baojia* units and related security institutions played important roles in managing local populations. Yet this infrastructure also retained features associated with the early Qing. These features included the production of ritual materials and the creation of administrative services that facilitated the movement of armies, officials, and information. The following sections examine how these institutions collectively sustained Qing calendrical authority.

1.2 Material Infrastructures

Calendars functioned as social and technical infrastructure in four main ways: through their format and design, their production process, their distribution networks, and their practical uses. First, the format and design of calendars represented status through physical artifacts. Second, the production of state calendars depended on specialized institutions, organized labor, and material practices with different forms of print technology. Third, the distribution of calendars required intricate collaboration and logistical management that connected the court to local communities. Finally, individuals used calendars to maintain their personal goals whether ritual scheduling, everyday life management, interpreting days, or simply as a cognitive tool to record and remember important facts of life.

[53] The name for the calendar was changed in the eighteenth century due to name taboos for the Qianlong Emperor. At this point it became the Shixian shu. For the history of the calendar debate, see Huang Yi-Long, "Ze Ri Zhi Zheng Yu 'Kangxi Li Yu' 擇日之爭與"康熙曆獄"," *Qing Hua Xue Bao* 21, no. 2 (1991): 247–80; Huang Yi-Long, "Court Divination and Christianity in the K'ang-Hsi Era," *Chinese Science* 10 (1991): 1–20.; Ping-Yi Chu, "Scientific Dispute in the Imperial Court: The 1664 Calendar Case," *Chinese Science* 14 (1997): 7–34.; Jami, "Revisiting the Calendar Case (1664-1669)."; Christopher Cullen and Catherine Jami, "Christmas 1668 and After: How Jesuit Astronomy Was Restored to Power in Beijing," *Journal for the History of Astronomy* 51, no. 1 (2020): 3–50; Christopher Cullen and Catherine Jami, "Prediction and Politics in Beijing, 1668: A Jesuit Astronomer and His Technical Resources in a Time of Crisis," *Journal for the History of Astronomy* 53, no. 4 (2022): 422–74.

Formatting Calendars

Calendar format and design formed part of this material infrastructure. Although layouts, scripts, tables, and materials reflected aesthetic choices, those choices also carried political and administrative significance. Design distinguished communities and groups, and different calendar forms reflected users' relationships to the state. These material features were not fully determinative; communities and officials negotiated their meaning and status. Nevertheless, layout, raw materials, and language were integral to the production of calendrical authority.

Calendar Layouts

Qing calendar layouts had formal structures and ideal designs (see
Table 1-2). They were not simply lists of dates. but small booklets or directories of calendrical information that readers could consult for specific days, seasonal transitions, and permissible actions. These structures were defined by law and incorporated into administrative statutes and precedents.

The formal structures included in the calendars post-1644 contained continuities from earlier periods.[54] Both Ming and Qing calendars opened with pages on capital times. The page of the capital times summarized the imperial calendar for the year. It contained the reign dates along with the stem and branch for the year. It then listed the twelve months (and intercalary months if necessary) in columns labeling each as a large or small month according to its length. Beneath each month heading, the columns contained the dates and times for each of the seasonal joints along with the stem-and-branch designation for each relevant day. Ming and Qing calendars differed slightly in the level of reported precision. Ming calendars measured these transitional moments down to the *ke* or fourteen-minute intervals, whereas the *Shixian li* reported the time down to the *fen* minute.

Calendar booklets from both dynasties also included tables and diagrams of supernatural influences. These influences had ancient origins, and medieval calendars had developed several

[54] There is an edition of the first calendar from 1644 which exist in the Shandong Library. Wang, Xiaohu, "Qing Shunzhi yuan nian zhi zao li huo dong: Cong Shandong sheng tu shu guan cang Shunzhi nian jian "Shi xian li" chu fa de kao cha 清顺治元年之造历活动 ———从山东省图书馆藏顺治年间《时宪历》出发的考察," *Zhongguo keji zazhi*, Vol. 40, no. 1 (2019), 10-18

diagrams for displaying this information.[55] Both the Ming and Qing tried to standardize these regulations and use the illustrations to provide the information for daily use. These illustrations showed the auspicious directions for the year and communicated other information. The terms followed the *houtian* 後天 sequence and divided space into twenty-four directions. These spaces contained the four trigrams, the four main stars, and lesser stars, many of which were treated as harmful influences.[56]

Table 1-2: Table of Qing Calendar Sections. Sources: Calendars from the National Central Library Microfilm Collection; Qing Administrative Regulations.

Section	Description
Wannian shujian/"red letter pages"	Calendar of auspicious days, imperial birthdays
Capital Times	Times of the 24 seasonal divisions in Beijing
Illustration of the Year Spirits	Illustration of the auspicious directions of the year and the relationship to various harmful or beneficial influences
Table of Sunrise and Sunset Times for Provinces	Lists of sunrise and sunset by provincial seats for Chinese Provinces and Korea
Table of Sunrise and Sunset Times for Mongolian Territories	Lists of sunrise and sunset times for Mongolia and Xinjiang
Table of Sunrise and Sunset Times for tusi Tribal Officials	Lists of sunrise and sunset times for locations in Tibet and Qinghai
Table of Seasonal Transitions by Province	Lists of time for seasonal transition for provincial seats for Chinese Provinces and Korea
Table of Seasonal Transitions by Mongolian Territories	Lists of time for seasonal transition for Mongolia and Xinjiang
Table of Seasonal Transition by tusi Tribal Officials	Lists of time for seasonal transition for Tibet and Qinghai
Calendar of Month, Day Activities	Contains the lists of prohibited and auspicious actions for every day of the year; also contains the lists of supernatural influences
List of Imperial Memorial Days	Contains the chronology of past 60 imperial years for use of ganzhi; contains marriage direction charts
Compilers	Lists the bureaucratic officials responsible for the compilation of the calendar

[55] Alain Arrault, "Les Calendriers Chinois: L'image Du Temps, Le Temps Dans Les Images," *Arts Asiatiques* 66, no. 1 (2011): 15-16.
[56] Richard J. Smith, *Fortune-Tellers and Philosophers: Divination in Traditional Chinese Society* (Westview Press, 1991), 79-80.

After adopting the *Shixian li*, the Qing added several new sections to the calendar. Because the calendar system was based on the celestial sphere and the concepts of latitude and longitude, the new calendar also became a kind of geographic directory that organized time by space. In preparing the first calendar of 1644, Adam Schall von Bell introduced these principles in the calendar booklets. He included brief explanations about the principle of latitude and longitude and used these calculations for all provincial units.[57] These features were significant innovations that connected the publication of time information to the actual territory that the state controlled. The first calendars under the *Shixian li* were consequently required by law to include this information. They had to state that the calendar was based on the use of the Western system and that all territories under the Qing were subject to these changes.[58]

Over time, the Qing removed notices identifying the calendar as based on Western methods. Yet calendar-making became increasingly tied to the construction of Qing territory.[59] For instance, although the princes of Khalkha Mongolia had exercised considerable autonomy in the early to mid-seventeenth century, the Kangxi emperor declared in the late seventeenth century that all Mongolian territories had to accept the calendar. Newly mapped territories were therefore added to calendar's lists of imperial territories.[60] For these places, the tables were updated to include sunrise and sunset times as well as seasonal transitions calibrated against Beijing.
From the eighteenth through the early nineteenth century, each expansion of Qing territory brought new cities and places into the formal structure of the calendar. These sections of the calendar reflected the different administrative structures. For instance, some tables listed Chinese provinces under the Ministry of Rites, whereas others listed Mongolian territories under the *Lifanyuan* 理藩院 Office of Colonial Affairs.[61] Each major update to the calendar corresponded

[57] Weng Lianxi, ed., *Qing Dai Nei Fu Ke Shu Tu Lu 清代內府刻書圖錄* (Beijing chu ban she, 2004), 240-241.; Qintianjian, *Da Qing Shunzhi Shi Wu Nian Sui Ci Wu Xu Shi Xian Li 大清順治十五年歲次戊戌時憲曆*, Microfilm (National Central Library, 1658).
[58] *Yongzheng Da Qing Hui Dian 雍正大清會典*, Jindai Zhongguo shiliao congkan san bian (1985), j. 246, 12a, 15519.
[59] For details on each city included, see Chunhua, "Lun Qing Dai Ban Xing 'Shi Ke Biao' Nei de Di Ming Te Dian 論清代頒行曆'時刻表'內的地名特點," *Ming Qing Lun Cong* 15 (2015): 447–58; Wang Yuanchong, "Qing Dai Shi Xian Shu Yu Zhongguo Xian Dai Tong Yi Duo Min Zu Guo Jia de Xing Cheng 清代時憲書與中國現代統一多民族的形成," *She Hui Ke Xue*, no. 5 (2018): 191-198.
[60] *Yongzheng Da Qing Hui Dian 雍正大清會典*, Jindai Zhongguo shiliao congkan san bian (1985), j. 246, 3b-5a, 15502-15505; j. 246, 13b, 15522.
[61] Dittmar Schorkowitz and Chia Ning, *Managing Frontiers in Qing China: The Lifanyuan and Libu Revisited* (Brill, 2016).

to key moments of Qing expansion, such as the addition of new towns after the defeat of the Zunghars or the incorporation of the Torghuts. State mapping projects also generated more precise data for locations in Manchuria.[62]

Calendar tables encoded not only geography but also political hierarchy. Only some states received permission to be included in the Qing calendar. One example was Korea, one of the first states added to the Qing calendar.[63] Just as Koreans negotiated their own printing of the calendars, the Qing state similarly adjusted how to represent Korea within the tables. Early calendars, such as the calendar of 1658, claimed to use latitude as the organization. Yet the tables also employed ranking by honor. In the tables of seasonal joints, they listed Korea above Chinese provinces and even Shengjing 盛京, the Qing's second capital.[64] Later calendars, however, restructured the organization to prioritize latitude more strictly, even though they continued to give first place as an honor to Shengjing regardless of its latitude.[65]

Neighboring states benefited from these associations too. By Qianlong 54 (1789), more states received the privilege to be added to the tables. These polities were no longer just recipients of the calendar. They were henceforth included in the actual lists included in the calendar data. The two other states that received this privilege were Annam and Ryukyu. Yet they were placed under the categories of Chinese provincial units according to their central latitude rather than as a separate section of tributary states, compared to places like Mongolia and Tibet.[66]

These material relationships mattered, but they were continually renegotiated under practical and political pressures. Calendars that were produced for imperial audiences tended to include detailed tables that represented all the places of the empire and the neighbors, but calendars that were produced primarily for Chinese provinces or local officials did not typically include this level of detail. The reasons for these variations are not always clear, since administrative regulations describe ideal calendar forms rather than actual manufacturing practices. Audience

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[62] Tuojin, ed., *Qing Hui Dian Shi Lie (Jiaqing) 清會典事列（嘉慶）*, Jindai Zhongguo shiliao congkan sanbian (Wen hai chu ban she, 1991), j. 830, 11a-13b, 4253-4258.

[63] Seonmin Kim, *Ginseng and Borderland: Territorial Boundaries and Political Relations Between Qing China and Choson Korea, 1636-1912* (University of California Press, 2017), 43.

[64] Qintianjian, *Da Qing Shunzhi Shi Wu Nian Sui Ci Wu Xu Shi Xian Li*.

[65] Qintianjian, *Da Qing Kangxi San Shi Wu Nian Sui Ci Bing Zi Shi Xian Li 大清康熙三十五年歲次丙子時憲曆*, Microfilm (National Central Library, 1696).

[66] Tuojin, ed., *Qing Hui Dian Shi Lie (Jiaqing) 清會典事列（嘉慶）*, Jindai Zhongguo shiliao congkan sanbian (Wen hai chu ban she, 1991), j. 830, 14a-14b, 4259-4260.; Qintianjian, *Da Qing Jiaqing Yuan Nian Sui Ci Bing Chen Shi Xian Shu 大清嘉慶元年歲次丙辰時憲書*, Microfilm (National Central Library, 1796).

mattered, discussed in greater detail further below. Certain audiences received special calendars that were designed specifically for those readers. This likely affected how binders combined different pages to create the booklets. For instance, many calendars only included the opening pages about times in Beijing and the illustrations of auspicious directions followed immediately by the month-day pages.

Many Jiaqing-period calendars in the National Central Library collection excluded tables entirely.[67] These calendars focused much more on daily activities of auspicious elections rather than the geographic times for sunrise and sunset for every major city in the empire. Other calendars were more selective in terms of the tables. For instance, there are several calendars that only provided the information for the Chinese provinces rather than for Mongolia and Tibet.[68] Thus, although ideal calendar structures incorporated all territories and places under Qing authority, surviving bindings and calendar examples show that these elements were flexible. Detailed territorial tables appeared only in calendars intended for audiences or offices for whom such information was useful or necessary.

Raw Materials

Although administrative regulations defined ideal calendar contents, actual calendars were modified according to audience. Materials, covers, seals, sizes, and languages marked social roles and bureaucratic rank. In this sense, calendars materialized a user's position within the Qing political order. Physical form therefore became a way to distinguish users according to their proximity to the throne and their place within the Qing administrative order. Building on earlier innovations in calendar-distribution rites, the imperial ceremony for granting calendars became a highly ordered event in which material objects represented status and political association. The ceremony officially recognized the printing of the calendar for the new year. At a symbolic level, however, it recreated a model of the empire through calendar artifacts, their appearance, and the ranked process by which they were distributed.

[67] See cases from Jiaqing 12, 13, 14, 16, 17, 21, 22, and 23, Microfilm (National Central Library).
[68] Qintianjian, *Da Qing Qianlong Wu Shi Er Nian Sui Ci Ding Mo Shi Xian Shu* 大清乾隆五十二年歲次丁未時憲書 (1787), 990084745670203941, Harvard Yenching Library.; Daoguang 29, 30 Microfilm (National Central Library).

The Qing standards modified the inherited regulations from the Ming calendar distributions.[69] The ritual occurred on the first day of the tenth lunar month and was a major palace event.[70] Participants included the emperor, empress, imperial concubines, imperial princes, ranked banner nobles, and much of the central bureaucracy in Beijing. Some regional officials were also brought to the palace for the ritual.[71] During the presentation, the director of the Imperial Astronomical Bureau lifted the calendar and carried it through the Meridian Gate. Accompanied by the vice director, he carried it to the Gate of Supreme Harmony at the front of the main palace. Then they handed over the calendar to the overseer of ritual implements. This figure took the calendar to the Gate of Heavenly Purity. Other attendees lined up opposite them, near the Gate of Loving-kindness. The ritual overseer then announced the presentation of the new calendar. The assembled participants moved to the center before the royal family and military officers, after which the calendar was distributed in ranked order.[72]

During the presentation of the calendar, the regulations distinguished the emperor from all other recipients. He received not one but three calendars. The three calendars were titled the *shangli* 上曆 "Imperial Calendar," *minli* 民曆 "Popular Calendar," and the *qizheng li* 七政曆 "Calendar of the Seven Luminaries." The calendars had slight differences in content. The "Imperial Calendar" and the "Popular Calendar" differed in terms of ritual content and prescribed activities.[73] The first contained information about rituals that were only conducted by the emperor, while the second contained general activities practiced by everyone. The Calendar of the Seven Luminaries was a specialized ephemeris that recorded planetary positions. It matched times of the year with the positions of the seven luminaries, i.e. planets. This calendar could then be used for creating horoscopes and astrological charts.

The raw materials used in making these calendars reflected their imperial significance. The *shangli* was for the emperor alone and therefore was handcrafted. It looked more like a devotional book than a codex. The Ministry of Rites prepared only a single *shangli* per year. Unlike every other state calendar, this calendar was composed entirely by hand in the highest quality

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[69] Thatcher E. Deane, "The Chinese Imperial Astronomical Bureau: Form and Function of the Ming Dynasty 'Qintianjian' from 1365 to 1627" (Phd Dissertation, University of Washington, 1989), 321-326.
[70] *Qin Ding Da Qing Hui Dian (Qianlong)* *欽定大清會典* (Wu ying dian, 1764), j. 27, 1a.
[71] *Qin Ding Da Qing Hui Dian (Qianlong)* *欽定大清會典* (Wu ying dian, 1764), j. 27, 1a-1b.
[72] *Qin Ding Da Qing Hui Dian (Qianlong)* *欽定大清會典* (Wu ying dian, 1764), j. 27, 1a-2a.
[73] Richard J. Smith, *Fortune-Tellers and Philosophers: Divination in Traditional Chinese Society* (Westview Press, 1991), 81-82.

calligraphy. That handwriting was also done on only the highest quality of paper. The *shangli* was also a bilingual document. It was written in both Chinese and Manchu for the emperor's perusal.

These calendars differed substantially from other calendars. One extant version of the calligraphic calendar entered the art market in 2022, and it offers an example to contrast the calendar with other calendars made for the distribution ceremony. The calendar dates to Yongzheng 2 (1724), and it is about the size of a handbill or pamphlet, 19 x 8.5 cm. The calendar is written in both vermillion and black ink. The red-ink entries emphasize features of the month, such as the stem and branch for the first day. Like the general format, the calendar begins with the months and seasonal transitions for Beijing in columns, but it combines Chinese and Manchu. Red ink also highlights auspicious days for imperial tasks. Since the calendar is not printed and bound, the calendar is folded within a yellow-silk cover. The fold is a special accordion fold called *jingzhe zhuang* 經摺裝 sutra binding. This was a style associated with devotional texts and Buddhist sutras.[74] In other words, the imperial calendars would have appeared much like other pamphlets of devotional literature in personal use. Nevertheless, considering that the calendar remains in pristine condition, it is unclear how often emperors consulted such artifacts.[75]

Although the emperor was the only person to receive the *shangli*, there were other colors and textiles used in calendar presentations. These elements linked status and rank to court relationships. The emperor's three calendars were placed on a table in imperial-yellow damask boxes. The boxes also had special covers made from thin yellow silk with gold filigree.[76] Imperial-yellow textiles were also used for calendars distributed to women of the imperial household. The *taihuang taihou* 太皇太后 Grand Empress Dowager, the *huang taihou* 皇太后 Empress Dowager, and the *huanghou* 皇后 Empress Consort all received printed copies of the *minli* and the *qizheng li* in Manchu and in Chinese.[77] These calendars were enclosed in the yellow damask cloth covers and gold-filigree silk cases.[78]

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[74] Edward Geral Martinique, "Chinese Traditional Bookbinding: A Study of Its Evolution and Techniques" (Masters Thesis, University of Chicago, 1972), 29-34.
[75] Neiwufu, *Lot 869: Yongzheng Er Nian Shi Xian Li 雍正二年時憲曆*, May 28, 2022, Paper, 19 x 8.5 cm, Christie's Auction, https://www.christies.com/zh/lot/lot-6375478.
[76] *Kangxi Da Qing Hui Dian 康熙大清會典*, Jindai Zhongguo shiliao congkan san bian (1985). j. 161, 2b-3a, 7740-7741
[77] *Yongzheng Da Qing Hui Dian*, Jindai Zhongguo shiliao congkan san bian (1985). j. 161, 3a, 7741
[78] *Yongzheng Da Qing Hui Dian*, Jindai Zhongguo shiliao congkan san bian (1985). j. 161, 3a, 7741

After the highest-ranked women in the empire, different colors and textiles continued to be attached to one's status and hierarchy. The imperial concubines according to their ranks were the *huang guifei* 皇貴妃 the Imperial Noble Consort, the *guifei* 貴妃 Noble Consort, the *fei* 妃 Consorts, and the *pin* 嬪 or third-ranked concubines. These groups received Manchu and Chinese *minli* and *qizheng li* calendars. But the materials differed from the consorts and within their own ranks. Upper-ranked concubines received silk covers in *gold-yellow* rather than *imperial yellow*, whereas third-ranked pin concubines received *red silk* coverings. Lower-ranked concubines only received book covers without cases.[79]

One of the most important distinctions concerned a group's relationship to the court and to the state seal. As official documents, calendars had to be certified by the relevant state office. The front cover of most calendars included a warning, stating that calendars had to receive the seal from the imperial astronomical bureau, and forgery of that seal would lead to severe punishment (see Chapter 2). The seal also marked a boundary between inner and outer court. As a part of the statutes on the materials used in creating imperial calendars, the *Collected Statutes* specify that the calendars distributed to the imperial family members were given without any state seals whereas all others were required to have their calendars stamped and certified with the seals. The sons of the emperor could receive calendars without seals, but other imperial relatives or lineage members who were no longer in the direct line did not have this privilege. Most elites received calendars that contained the state seal. Since these categories were a part of the distribution process, the ceremony made this distinction present. Each group received the different type at the same moment, marking their status and association with each other.

Besides textiles physical size corresponded to status hierarchies. Calendar types came in multiple physical dimensions. In Kangxi 11 (1672), the Board of Rites added new distinctions between size formats. These classified calendars into two main sizes "large-format" and "small-format" editions. The emperor was permitted to receive all types of the sizes, but only lower ranks received "small-format" editions. These new small format editions were exclusively built for the Popular Calendars. These pocket editions were meant to be more portable calendars, but they also reinforced the material distinctions in rank.[80] By making the Popular Calendars in smaller sizes

[79] *Yongzheng Da Qing Hui Dian*, Jindai Zhongguo shiliao congkan san bian (1985). j. 161, 3a-3b, 7741-7742
[80] *Yongzheng Da Qing Hui Dian*, Jindai Zhongguo shiliao congkan san bian (1985). j. 161, 4a, 7743

and restricting large-format sizes to only the highest ranks, the physical dimensions created another layer of reinforcing status distinctions through appearance.

Language

Language was another material feature through which calendars classified status and community. Official calendars appeared in Chinese, Manchu, and Mongolian, the three principal written languages of Qing administration and banner identity. The language of a calendar, obviously, facilitated the meaning of the content. Different communities had access to the system because of translation. Nevertheless, language solidified identities. The language of one's calendar linked those users to administrative categories, banner associations, and political relationships with the court.

In the seventeenth century, official ceremonies included translations of the calendar in all three official languages. This reflected the unique position of Mongolian in early Manchu-Mongol alliances. Mongol khanates forged alliances with the Manchus under varying conditions, but one persistent feature of these relationships was marital exchange. Many imperial wives and consorts came from Mongol lineages, and imperial princesses married into Mongol princely lines.[81] During the Kangxi period, the empress dowager Xiaozhuangwen 孝莊文 (1613-1688), who had an important role in the emperor's early life, was a Khorchin Mongol.[82] Due to these marriage alliances, the women of the court were permitted to have Mongolian language calendars. They initially were supposed to receive only Manchu and Chinese, but they wished to have Mongolian copies for their reading. The imperial policy shifted in the early nineteenth century. Although imperial princesses continued to be married to Mongol princes, Mongolian was no longer as common in court life and became less frequently printed for court officials.[83]

If the majority of calendars were published in Chinese, what was the significance of Manchu and Mongolian? Manchu and Mongolian were mostly used to reinforce ethnic difference. Banner association, for instance, was linked to calendar language. Manchu calendars were sent to

[81] Evelyn S. Rawski, *The Last Emperors: A Social History of Qing Imperial Institutions* (University of California Press, 1998), 66-71, 131, 147.
[82] M. Jean Gates and Chao-ying Fang, "Hsiao-Chuang Wên Huang-Hou," in *Eminent Chinese of the Ch'ing Period (1644-1912)*, vol. 1, ed. Arthur W. Hummel (U. S. Govt. Print. Office, 1943), 300-301.
[83] Tuojin, ed., *Qing Hui Dian Shi Lie (Jiaqing) 清會典事列（嘉慶）*, Jindai Zhongguo shiliao congkan sanbian (Wen hai chu ban she, 1991), j. 830, 15b, 4262.

the Manchu garrison populations throughout China, and Mongolian calendars were sent to Mongolian bannermen. In the same way, the Han bannermen were supposed to receive Chinese-language calendars. What if a garrison contained bannermen from multiple ethnicities? Even in such cases, calendars were distributed to reflect ethnicity. Garrisons had to report the ethnic composition of their bannermen, and these demographics determined the proportion of calendars sent in each language.

Similar language politics shaped calendar distribution beyond China proper. States like Korea, Vietnam, and Ryukyu were classified as tributary states with special status. When they traveled to Beijing to collect calendars or participate in ceremonies, they were largely administrated under the Board of Rites. China proper was also listed under the Board of Rites. As a result, these places also only received Chinese-language editions of the calendar.[84] But Mongolia and Manchuria were largely administered through the Lifanyuan. Manchu and Mongolian were the administrative languages used in the Lifanyuan. Mongolian princes received both Manchu and Mongolian editions of calendars. But the Mongolian garrisons, as Mongolian banners, were primarily given Mongolian editions, although the governor-general in Urga also received Chinese-language editions.[85] Similarly, Manchu princes received Chinese and Manchu editions, but the northern tribes in Heilongjiang were treated as a special category of "Old Manchus". They were only given Manchu editions then as a part of the promotion of these groups in maintain Manchu identity.[86]

The circulation of multilingual calendars also helped train readers. Because calendars were daily necessities used for scheduling and planning, they served as practical language aids. They contained information for scheduling and planning. When many Manchu bannermen became more fluent in Chinese than Manchu over the course of the eighteenth century, Manchu calendars served as key translation aids to both promote Manchu-language policy and to provide accurate terms for understanding how to use the calendars for planning. Reports about calendars and language policy

[84] *Qin Ding Da Qing Hui Dian (Qianlong) 欽定大清會典* (Wu ying dian, 1764), j. 27, 2b.
[85] Zhang Rongzheng, ed., *Qin Ding Li Fan Bu Ze Li 欽定理藩部則例* (Tianjin gu ji chu ban she, 1998), j. 23, 2b-4b, 230-231.
[86] Chunhua, "Lun Qing Dai Man Wen 'Shi Xian Shu' Nei Rong Ban Ben Ji Ban Fa 論清代滿文'時憲書'內容版本及頒發," *Jilin Shifan Daxue Xuebao Renwen Shehui Kexue Ban*, no. 1 (2018): 76–77.; For more on language policy, Evelyn S. Rawski, *The Last Emperors: A Social History of Qing Imperial Institutions* (University of California Press, 1998), 36-39.; Pamela K. Crossley, *A Translucent Mirror: History and Identity in Qing Imperial Ideology* (University of California Press, 2002), 298-300.

emphasized that garrisons collected more Chinese calendars than Manchu calendars, but these were options for creating better language policy.[87]

Manchu calendars also served this role in other contexts. The Yonghe gong monastery in Beijing included a school for teaching and learning astronomy. While the Tibetan calendar differed in certain aspects from the state calendar, the techniques were used in these monasteries and diffused throughout Mongolian and Tibetan networks.[88] Qing calendars helped coordinate and standardize these procedures in calendar making. The monastery received Mongolian-language state calendars, and the monastery received Manchu-language copies of the "Seven Luminaries Calendar".[89] As an ephemeris, this would have been beneficial for Buddhist astrology.

Several annotations on a Manchu-language calendar for 1783 further attest to this practical orientation. The calendar, which is held in the library of the Société Asiatique, contains handwritten entries throughout the year. The calendar contains a final note on 12.20 about the "start of our calendar for 1784" which has led scholars to believe that this calendar was owned and annotated by one of the officers in the Russian corps, a unique sub-unit in the banner system. The entries include notes on the weather (rain, snow), and life in the capital. For instance, the military official noted the birthday of the God of Wealth on 9.17, the distribution of the calendar on 10.01, the military exams from 10.05 to 10.10, and the day of public executions on 11.12. He made notes of when the Emperor traveled and left the capital for Mukden. The calendar also points to his own language training. On 11.09, he wrote about the arrival of a new Manchu teacher Taifingga, and the start of their lessons on 11.17.[90]

These material distinctions also changed over time as status hierarchies shifted. In Qianlong 17, for example, princes were granted an exemption to distinguish the quality of their calendars. They were granted the right to use higher-quality *pangzhi* 磅紙 paper.[91] In Qianlong

[87] Wang Yuanchong, "Qing Dai Shi Xian Shu Yu Zhongguo Xian Dai Tong Yi Duo Min Zu Guo Jia de Xing Cheng 清代時憲書與中國現代統一多民族的形成," *She Hui Ke Xue*, no. 5 (2018): 199.

[88] Lobsan Yongdan, "A Scholarly Imprint: How Tibetan Astronomers Brought Jesuit Astronomy to Tibet," *East Asian Science, Technology, and Medicine* 45 (2017).; Sokhyo Jo, "Topics on the History of Tibetan Astronomy with a Focus on Background Knowledge of Eclipse Calculations in the 18th Century" (Phd Dissertation, Harvard University, 2016).

[89] Zhang Rongzheng, ed., *Qin Ding Li Fan Bu Ze Li 欽定理藩部則例* (Tianjin gu ji chu ban she, 1998), j. 23, 4b, 231.

[90] Alice Crowther, "Les Annotations Manuscrites d'un Calendrier Mandchou Conservé à La Société Asiatique," *Journal Asiatique* 310, no. 1 (2022): 135–39.

[91] Tuojin, ed., *Qing Hui Dian Shi Lie (Jiaqing) 清會典事列（嘉慶）*, Jindai Zhongguo shiliao congkan sanbian (Wen hai chu ban she, 1991), j. 830, 19b, 4270.

46, the emperor also shifted the materials used in covers. Each of the ranks started to use packets instead of the boxes for containers.[92] Shifts in the material products related to other forms of jockeying for status among ranks. The imperial sons petitioned to have the right to wear three-eyed peacock feathers around the same time, even as Mongolian bannermen also started to request to wear these types of accoutrements to display their status.[93]

The calendar-presentation ritual linked palace ceremony to the widespread use of calendars in everyday life. Although the ritual centered on the emperor and the central bureaucracy, it had local counterparts that reinforced similar relationships in more specific contexts. The ritual process heightened distinctions between superior and inferior, insider and outsider. These hierarchies took material form in calendar content, design, language, seals, covers, containers, and size. Each component of the calendar—from its textual contents to its physical format and the recipient's location in the ceremony—defined how groups related to one another. These distinctions also shaped how calendars could circulate, who could use them, and what forms of authority they carried.

Production

The second characteristic of calendrical infrastructure was production. Materiality shaped not only the design and layout of calendars but also the processes through which they were made. Calendar production belonged to the larger infrastructure of printing and publishing. It required typesetters, carvers, editors, printers, binders, copyists, and officials, all of whom participated in different stages of manufacture. This production process operated at two main levels. At the highest level, government printing offices managed large print orders and supplied much of the administrative apparatus. At the same time, because the government also produced civil calendars for wider use, calendar production depended on local craft and commercial printing.

Local production increased the diversity of calendar forms. Like imperial gazettes, locally printed calendars followed models based on official sources, but publishers and printers adapted those models to immediate resources and local conventions. These conditions produced variation

[92] Tuojin, ed., *Qing Hui Dian Shi Lie (Jiaqing) 清會典事列（嘉慶）*, Jindai Zhongguo shiliao congkan sanbian (Wen hai chu ban she, 1991), j. 830, 19b-20a, 4270-4271.

[93] Zhaolian, *Xiao Ting Xu Lu 嘯亭續錄 [Additional Records from the Whistling Pavilion]* (Jiusitang, 1880), j. 1, 12a-12b.

in paper, printing style, layout, and customary additions. As a result, calendars that claimed official status often overlapped in appearance with unofficial calendars. Over time, official calendar businesses became increasingly visible as printers added their names to their editions and advertised themselves as authorized resellers or re-printers. Close attention to individual editions therefore reveals the importance of local actors in shaping calendar form. Although official calendars were theoretically standardized objects, the practices involved in producing them created diverse, locally embedded experiences of reading and use.

Technical Reference Works

Calendar production depended on more than the annual calendars distributed through court ritual. The imperial family received the standard state calendar associated with the *Shixian li* and the Calendar of the Seven Luminaries, which allowed users to check celestial positions and track planetary movements. Yet these were only two documents within a broader print ecosystem that made calendar production possible. Official textbooks, reference tables, perpetual calendars, and night-watch guides all supplied the information and formats needed to produce annual calendars and the information used to determine daily signals for knowing the time.

Calendar making was based on common knowledge that circulated through resources and textbooks that the government published to help compile calendars. Some of the most important books in this category were the official textbooks in astronomy and mathematics, such as *Lüli yuanyuan* 律曆淵源 (1722) which included the *Lixiang kaocheng* 曆象考成, *Shuli jingyun* 數理精蘊, and the *Lülü zhengyi* 律呂正義. The series continued to be revised throughout the dynasty as new tables and instruments were added. Another important textbook was the *Xieji bianfang shu* 協紀辨方書 (1739), which became the standard volume in judicial and administrative astrology. There were different editions of these books available, and one could buy them directly from the printing offices in Beijing or through commercial printers.[94] The state funded large print runs to distribute them to regional governments. The Qianlong emperor required the publishing bureau to produce enough copies for provincial officials as well as to state-sponsored local academies. The state had to hire even more workers specifically for these projects.[95]

[94] Commercial editions especially grew from the 1850s onwards. For bibliographies of editions, see Li Di, *Zhongguo Suan Xue Shu Mu Hui Bian 中國算學數目匯編* (Beijing shifan daxue chuban she, 2000). 507-510

[95] Tuojin, ed., *Qing Hui Dian Shi Lie (Jiaqing) 清會典事列（嘉慶）*, Jindai Zhongguo shiliao congkan sanbian (Wen hai chu ban she, 1991), j. 830, 40a, 4311.; QSL QL 6.11.5

Two special books used as references in producing calendars were the *Wannian shu* 萬年書 and the *Sanyuan jiazi* 三元甲子. These books were not textbooks insofar as they did not focus on instructing readers. Rather they functioned more like reference tables where a reader could scan the documents for specific information about dates and the related activities or relationships to stems and branches. The *Wannian shu* was especially important for the almanac information of the calendar. It contained lists of combinations with prepared activities. Although one could use textbooks to learn how to make predictions, the *Wannian shu* already provided prepared versions of much of this information. In other words, it simplified the process for showing influences and auspicious day selection. For example, following the gridded breakdown of year spirits in relation to months and stem-branch combinations, the book organized each section by month. These month pages were templates and models that could then be reused in the construction of calendars for future years. Within each month section, the calendar incorporated each of the 60 stem and branch combinations with the establishment days so that an almanac-maker could then find the stem and branch and add the appropriate auspicious or inauspicious event according to the day.[96]

The Sanyuan jiazi was also an almanac reference source. The *Sanyuan jiazi* was a historical work that provided sources on Chinese historical chronology and the coordination of imperial dates with the sexagesimal system.[97] Because the reference works were designed in relation to an imperial reign, they were republished and updated for each new emperor.[98] They were a "perpetual" or "10,000 year" calendar because they projected years from the start of an emperor's reign many years into the future. According to purchase records, these reference works were, in fact, among the most popular calendrical items sold by the government's official bookstore.[99]

A third type of work that supported this process of calendar making was the *Zhongxing genglu* 中星更錄. These booklets were guides for tracking hours at night, and they are particularly instructive for understanding how print shaped timekeeping infrastructure. Only a small number of these documents survive. Together with administrative and archival records, the extant booklets

[96] Qintianjian, *Wan Nian Shu 萬年書* (Kangxi Period), Harvard Yenching Library.
[97] Qintianjian, *Yu Zuan Li Dai San Yuan Jia Zi Bian Nian 御纂歷代三元甲子編年* (Guangxu Period), Staatsbibliothek zu Berlin.
[98] Tuojin, ed., *Qing Hui Dian Shi Lie (Jiaqing) 清會典事列（嘉慶）*, Jindai Zhongguo shiliao congkan sanbian (Wen hai chu ban she, 1991), j. 252, 10a, 75; j. 830, 11b, 4254, 13b, 4258.
[99] Weng Lianxi, *Qing Nei Fu Ke Shu Dang an Shi Liao Hui Bian 清内府刻書檔案史料彙編* (Guang ling shu she, 2007), 693, 704-705, 705-706, 706-707, 711-712, 717, 720-721.

show that they functioned as memory aids and reference tools for nighttime timekeepers and the city watch.[100] The documents used stars as reference points for different times of the night. These stellar times were then linked to the solar cycle. Using these coordinates, readers could identify sunrise and sunset times for a given period of the year and calculate the changing length of the nighttime geng watches. The booklets were more than tables. They included drawings and illustrations that explained how to track time at night and provided basic guidance for keepers of the drum and bell towers..

Although administrative documents do not include these calendars in the records about the Ministry of Rites and the official ceremonies, records from the publishing bureau the Wuying dian and the imperial workshops indicate that these calendars were meant to be used alongside other official calendars. They were supposed to be submitted to the emperor by the first day of the tenth month, just like state calendars.[101]

Payment records from the publishing bureau support this conclusion. According to a payment record for work from 1850, the office prepared several calendar items: six copies of the state calendar, six prints of the shortened version of the *Wannian shu*, a new print of the upcoming year's stars to know, and one copy of the *Zhongxing genglu*.[102] In preparing the document for printing, the Astronomical Bureau first produced models that were sent to the Wuying dian. The publishing bureau then hired out copyists to produce clean copies. These copies were supposed to be written in Song-style calligraphy.[103] Copyists, even though they were hired as day-laborers rather than permanent employees, could requisition supplies like paper, ink, and glue, from the Guangchusi 廣儲司, which was the storehouse for the Neiwufu, the Imperial Household. Once the new drafts were completed, the Wuying dian then used its internal artists to draw the illustrations. They then created regulated forms that allowed for the sheets to be transferred to the print shop where printers then produced the formal prints.

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[100] Qintianjian, *Wan Nian Zhong Xing Geng Lu San Yuan Heng Xing Tu Shuo Ge Sheng Bei Ji Gao Du Pian Du Biao 萬年中星更錄三垣恆星圖說各省北極高度偏度表* (1736), Sinica 868, Bodleian Library.; Qintianjian, *Wan Nian Zhong Xing Geng Lu San Yuan Heng Xing Tu Shuo Ge Sheng Bei Ji Gao Du Pian Du Biao 萬年中星更錄三垣恆星圖說各省北極高度偏度表* (post-1744), A02742, National Lbrary of China.

[101] Kungang, *Qin Ding Da Qing Hui Dian (Guangxu) 欽定大清會典 光緒* (Shang wu yin shu guan, 1908), j. 1200, 4a

[102] Weng Lianxi, *Qing Nei Fu Ke Shu Dang an Shi Liao Hui Bian 清内府刻書檔案史料彙編* (Guang ling shu she, 2007), 621.

[103] The administrative records explain that these pay rates changed over time. The scribes were initially paid at a rate of 0.02 tael per hundred characters in 1751, and then at a rate of 0.03 tael per hundred characters in 1795.

These were decorative style sheets. These documents existed outside of other networks of distribution. Since they were not included in the official ceremony, they were not formally affixed to ritual deadlines. But because they were used in the daily administration of the office, they were supposed to be delivered to the various offices before the last day of the lunar year.[104]

Woodblock and Color Printing

The diversity of calendar forms was inseparable from the technologies used to produce them. From the perspective of print history, the Qing government was an important innovator, experimenting with production techniques that could maintain quality while improving efficiency. The Wuying dian famously used copper movable-type printing during the compilation and printing of the *Gujin tushu jicheng* 古今圖書集成, a project that produced roughly 230,000 to 250,000 pieces of type in large and small sizes [105] Although copper type allowed for detailed illustration, it proved less cost-effective over the long term.[106] The Wuying dian also gained a reputation for high-quality wooden movable type. During the production of the *Siku quanshu*, the Qianlong Emperor commissioned the Wuying dian to print a special collectanea of rare books discovered from the archives and through the state-wide collection process. The director Jin Jian 金簡 (?-1794/5) argued in favor of using movable wooden type instead of woodblocks to save costs.[107]

These print technologies mattered for calendar production because they organized labor in distinct ways and required specialized practices. Although it is difficult to determine from appearance alone whether the product was made by movable type or woodblock, archival records from the publishing bureau indicate that typography did have its place. One set of Tongzhi-period payment registers includes records concerning the production of calendar handbooks and reference

[104] Kungang, *Qin Ding Da Qing Hui Dian (Guangxu) 欽定大清會典 光緒* (Shang wu yin shu guan, 1908), j. 1200, 4a

[105] Shiow Jyu-lu Shaw, "The Imperial Printing of Early Ch'ing China, 1644-1805" (Phd Dissertation, University of Chicago, 1974), 52-56; Christine Moll-Murata, *State and Crafts in the Qing Dynasty (1644-1911)* (Amsterdam University Press, 2018), 219-221.; Weng Lianxi, *Qing Dai Nei Fu Ke Shu Yan Jiu 清代內府刻書研究*, vol. 2 (Zi jin cheng chu ban she, 2013), 250-266.

[106] The government produced several special editions of high-quality mathematical and astronomical texts using this technique. Weng Lianxi, *Qing Dai Nei Fu Ke Shu Yan Jiu 清代內府刻書研究*, vol. 2 (Zi jin cheng chu ban she, 2013), 264-266. Copper-type printing, however, remained limited to these early experiments. Christine Moll-Murata, *State and Crafts in the Qing Dynasty (1644-1911)* (Amsterdam University Press, 2018), 220-221

[107] Jin Jian, *Qin Ding Wu Ying Dian Ju Zhen Ban Cheng Shi 欽定武英殿聚珍版程式*, SKQS (Wu ying dian, 1776); Richard C. Rudolph, *A Chinese Printing Manual* (The Ward Ritchie Press, 1954).

works. The reference books cited included the *Sanyuan jiazi* and *Wannian shu* calendars, which had to be updated in the first year of the Tongzhi reign. Several details from the registers suggest that the office used movable type to print them. The record used the payments for hired and in-house character carvers. Because some characters contained mistakes, the office also paid additional carvers to correct them. The office further submitted payments for grid boards, tools for aligning the pages and arranging type in columns as a part of the registration process.[108]

Official prints reveal even more about the growing importance of color printing. Color printing was not itself new. Some of the earliest multicolor prints already date to the Tang dynasty. Color increased the appeal of a print, but it introduced challenges for how to make impressions. One of the simplest solutions was an old practice called *shuangyin* 雙印 which meant to make two impressions. In this method, the printer worked with a single woodblock. He applied black ink to the relevant areas on the block, and he then made the first impression against the paper. He applied a second color to the remaining areas of the block and made another impression on the paper to add the second color. He could repeat the process to add more colors.[109]

However, since woodblocks wore down after repeated impressions, printers developed more sophisticated techniques using multiple blocks and careful registration. By the Qing period, these multicolor printing methods were typically divided into two categories: *taoban* 套版 and *douban* 餖版.[110] *Taoban* printing was the simpler of the two. In this method, carvers prepared multiple blocks, and printers inked each block with its respective color. Each color block had to be matched with the original frame and layout. In *douban* printing, carvers and printers assembled the multiple colors from modular blocks. This method granter greater control over the hues but required greater attention to details during the carving and a fixed grid to align the components.

The official printing office used *taoban* methods to produce black-and-red editions. In bibliographic terms, such calendars are classified as *zhumo taoyin ben* 硃墨套印本 or "black and

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[108] Weng Lianxi, *Qing Nei Fu Ke Shu Dang an Shi Liao Hui Bian* 清內府刻書檔案史料彙編 (Guang ling shu she, 2007), 651. For other payments, see Weng Lianxi, *Qing Nei Fu Ke Shu Dang an Shi Liao Hui Bian* 清內府刻書檔案史料彙編 (Guang ling shu she, 2007), 652-654, 656

[109] David Barker, *Traditional Techniques in Contemporary Chinese Printmaking* (University of Hawai'i Press, 2005), 11-12.; Cynthia J. Brokaw, "Introduction: The Colour Print and Early Modern Chinese Society," in *Handbook of the Colour Print in China 1600-1800*, ed. Anne Farrer and Kevin McLoughlin (Brill, 2022), 1.

[110] Several other terms for color printing techniques include *duoyin* 多印, *yiban duose* 一版多色, *fucai* 敷彩, *shuiyin tai* 水印台. Cynthia J. Brokaw, "Introduction: The Colour Print and Early Modern Chinese Society," in *Handbook of the Colour Print in China 1600-1800*, ed. Anne Farrer and Kevin McLoughlin (Brill, 2022), 1-2.

red ink editions".[111] The prints used black ink for the body text and red ink for annotations and other elements. Official calendars, however, were not originally made with color. Color entered calendar design gradually. Some early prints contain two colors, but they are not true multi-color prints. In Kangxi-period calendars, the front pages are covered with red ink. These pages were added before the rest of the calendar.[112] These early prints included pages in two colors, but technically they were not produced through color registration on the same page. Instead, printers prepared separate blocks for pages with red and pages with black ink.

During the Yongzheng reign, the printing office began publishing two-color calendars. The earliest example I have found dates to Yongzheng 4 (1726). The calendar is of high-quality. It contains lists of provincial times as well as times in Mongolian provinces, placing the calendar among higher-ranked calendars rather than the general popular calendars. The introductory material is entirely in black ink, but the days and months contain both black and red. The black ink supplies the information of the month and the day. Red ink, although highly faded today, is visible in the top row, the row which marks the changing phases of the moon. Another layer of red ink appears above the body text with columns of characters aligned to corresponding column below. As later calendars make clear, these red-ink layers depict the lists of influences and officially sanctioned days based on the standardized almanac information. They served as daily annotations and followed models similar to those in the *Wannian shu*.[113]

Administrative sources do not explicitly state that printing methods changed, but they do indicate that color became important for annotations. The section on calendar production in the *Collected Statutes* provides notes on adding red ink. The Yongzheng emperor updated calendar-making in Yongzheng 13 (1735). He published an edict requiring annotations for the fasting days which were necessary before certain state rituals.[114] He asked that these entries be marked with circles, and that the same marker be used for noting taboo days.[115]

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[111] Weng Lianxi, *Qing Dai Nei Fu Ke Shu Yan Jiu 清代內府刻書研究*, vol. 2 (Zi jin cheng chu ban she, 2013), 278-286

[112] For some discussion about these red pages, see Richard J. Smith, "A Note on Qing Dynasty Calendars," *Late Imperial China* 9, no. 1 (1988): 127.; Carole Morgan, "De l'authenticité Des Calendriers Qing," *Journal Asiatique* 271, nos. 3–4 (1983): 367.

[113] Qintianjian, *Da Qing Yongzheng Si Nian Sui Ci Bing Wu Shi Xian Li 大清雍正四年歲次丙午時憲曆*, Microfilm (National Central Library, 1726).

[114] For more on this practice, see Vincent Goossaert, "Periodic Fasting and Religious Calendars in China, 1700–1950," *Twentieth-Century China* 49, no. 3 (2024): 188–210.

[115] Tuojin, ed., *Qing Hui Dian Shi Lie (Jiaqing) 清會典事列（嘉慶）*, Jindai Zhongguo shiliao congkan sanbian (Wen hai chu ban she, 1991), j. 830, 10b, 4252.

A survey of extant library calendars suggests two conclusions about this practice. First, red-ink annotation became increasingly common in the second half of the eighteenth century. Many Qianlong-era calendars were printed with both black and red ink on the calendar day pages. Nevertheless, by the nineteenth century, color was nearly omnipresent. Almost every extant official calendar I have examined from the Jiaqing period onwards contains these annotations.[116] Second, color printing was tied to other material practices and audience distinctions. Although the earliest examples of the color prints are included in elite calendars, the practice became especially common in the smaller format calendars designed for popular readers. These calendars were either physically smaller or omitted most of the detailed geographic tables. They were designed as everyday calendars for readers outside the government.

These practices were also consequential for labor organization. Since color printing required additional steps in registering the block and the sheets, carvers and printers had to coordinate their efforts using grid techniques. Block carvers had to prepare a second set of blocks that allowed for the red annotations to be printed outside the main block of text.[117] One of the clearest is a calendar at Harvard dated Tongzhi 9 (1870).[118] Its vibrant colors remain well-preserved, rendering the printing process particularly visible (see Figure 1-3). During printing, the second block had to be carefully aligned to the first block. Two columns for the first day of the month contain so many notes on auspicious and inauspicious actions that they fill the entire column. In many cases, the printer could align the red annotations with the bottom frame. In this column, however, there was no white space. The second block therefore had to be adjusted to the length of the column, forcing the annotations outside the frame. This process required significant coordination among carvers, printers, and layout planners.

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[116] Qintianjian, *Da Qing Qianlong Shi Ba Nian Sui Ci Gui You Shi Xian Shu 大清乾隆十八年歲次癸酉時憲書*, Microfilm (National Central Library, 1753).; Qintianjian, *Da Qing Qianlong Er Shi Jiu Nian Sui Ci Shen Jia Shi Xian Shu 大清乾隆二十九年歲次申甲時憲書*, Microfilm (National Central Library, 1764).; Qintianjian, *Da Qing Qianlong San Shi Nian Sui Ci Yi You Shi Xian Shu 大清乾隆三十年歲次乙酉時憲書*, Microfilm (National Central Library, 1765).; Qintianjian, *Da Qing Qianlong San Shi San Nian Sui Ci Xu Zi Shi Xian Shu 大清乾隆三十三年歲次戊子時憲書*, Microfilm (National Central Library, 1768).; Qintianjian, *Da Qing Qianlong Wu Shi San Nian Sui Ci Xu Shen Shi Xian Shu 大清乾隆五十三年歲次戊申時憲書*, Microfilm (National Central Library, 1788).

[117] Zhang Xiumin, *Zhongguo Yin Shua Shi 中國印刷史* (Shanghai ren min chu ban she, 1989), 568-569.; Cynthia J. Brokaw, "Introduction: The Colour Print and Early Modern Chinese Society," in *Handbook of the Colour Print in China 1600-1800*, ed. Anne Farrer and Kevin McLoughlin (Brill, 2022), 2.

[118] Qintianjian, *Da Qing Tongzhi Jiu Nian Sui Ci Geng Wu Shi Xian Shu 大清同治九年歲次庚午時憲書* (1870), 990084745820203941, Harvard Yenching Library.

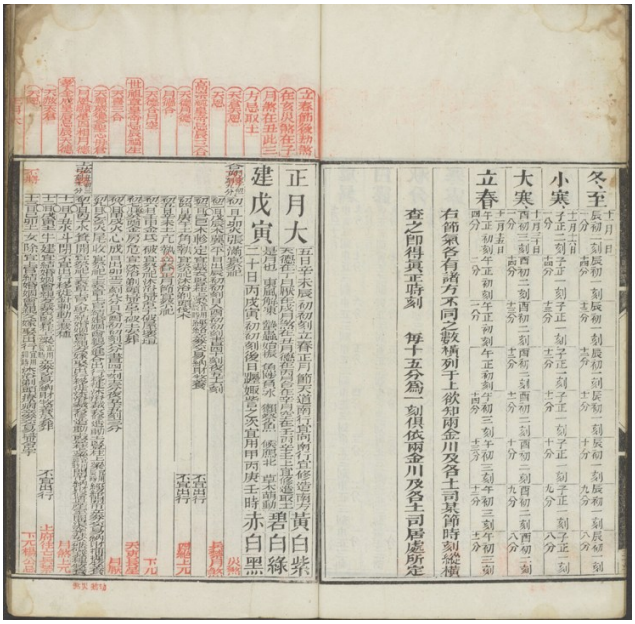


Figure 1-3: First page of the calendar months and days from 1870. Source: Harvard-Yenching Library

This practice rested on a two-block registration system. Although the Harvard example is particularly well-coordinated, many calendars do not display the same accuracy. Many extant calendars suggest that printing offices often prioritized rapid production over careful alignment. For instance, an official calendar from Daoguang 8 (1828) achieves the right effect with the upper boundaries but was not measured correctly for the bottom of the page. It is significantly higher up than it is supposed to be, as if it had been designed for a calendar of different dimensions.[119] A calendar from Daoguang 20 (1840) also shows careless printing. The printer failed to align the blocks, leaving the red ink on a diagonal rather than the straight line.[120] An official calendar from Jiaqing 25 (1819) was either printed so hastily or with such poor-quality ink that the red annotations are almost completely invisible.[121]

Despite the variation in quality, color printing became embedded in the infrastructure of official printing. According to statutes concerning the printing office, the office procured and

[119] Qintianjian, *Da Qing Daoguang Ba Nian Sui Ci Wu Zi Shi Xian Shu* 大清道光八年歲次戊子時憲書 (1828), 990084745710203941, Harvard Yenching Library.
[120] Qintianjian, *Da Qing Daoguang Er Shi Nian Sui Ci Geng Zi Shi Xian Shu* 大清道光二十年歲次庚子時憲書 (1840), 990084745760203941, Harvard Yenching Library.
[121] Qintianjian, *Da Qing Jiaqing Er Shi Wu Nian Sui Ci Geng Chen Shi Xian Shu* 大清嘉慶二十五年歲次庚辰時憲書 (1819), 990084745700203941, Harvard Yenching Library.

prepared red inks for its prints.[122] Because vermilion ink was also used for imperial notes and annotations, the office preserved its own recipes. Ink preparation formed part of the office's broader practices for processing raw materials. In other words, the material practices of printing were not limited to paper, glue, and wood. They also included the preparation and management of inks, which became essential to the technologies of color printing.

Local and Commercial Partners

The third dimension of calendar production was its local and commercial ecology. Although the Wuying dian produced large numbers of calendars and distributed models to the provinces, provincial officials depended on local partners to reproduce and circulate calendars beyond the central institutions of Beijing. Because provincial offices relied on local printers and commercial partners, official calendar production often took place within the same technical and commercial environments that produced popular almanacs, religious prints, gazettes, directories, and even unofficial calendars. Printing official calendars therefore often overlapped with the more expansive sphere of commercial printers in surprising ways.

Calendar production belonged to the responsibilities of the *buzheng shisi* 布政使司 Provincial Administration Commission.[123] Ranked below the positions of the governor-general and the provincial governor, the Provincial Administration Commissioner managed communications between the central and provincial governments and supervised regional offices, buildings, and fiscal affairs, including the provincial treasury. Each Qing province had its own commissioner, making the Provincial Administration Commission a key institution in the provincial production and distribution of calendars.[124]

The Provincial Administration Commission prepared the calendars used in the local "granting the seasons" ceremony. According to the *Collected Statutes*, the Provincial Administration Commission worked with the relevant offices in Beijing, i.e. Ministry of Rites, Imperial Astronomical Bureau, Wuying dian, to collect the materials needed to prepare calendars

[122] Kungang, *Qin Ding Da Qing Hui Dian (Guangxu) 欽定大清會典 光緒* (Shang wu yin shu guan, 1908), j. 1200, 3b-4a

[123] *Qin Ding Da Qing Hui Dian (Qianlong) 欽定大清會典* (Wu ying dian, 1764), j. 27, 2a.

[124] Charles O. Hucker, *A Dictionary of Official Titles in Imperial China* (Stanford University Press, 1985), 127.; T'ung-tsu [Tongzu] Ch'ü [Qu], *Local Government in China Under the Ch'ing* (Harvard University Asia Center, 1962), 6.

and conduct the ceremony. Each office received a version of the state seal of the Imperial Astronomical Bureau which they stored in the provincial treasury. This was the seal that they used to authenticate state calendars. In preparation for the local presentation performed on the same day as that of Beijing (i.e. first day of the tenth month of the year), the office received a model copy of the people's calendar lacking a seal that they used to create local reproductions. The office was responsible for providing the required number of calendars for administrative officials and for wider sale to interested parties.[125] Although some provincial offices had access to government printers for the province, provincial-level offices hired out this work through local partners.[126]

Local ecology impacted calendar production firstly through the collecting of taxes to pay for calendar printing. Each district collected funds and remitted them to the Provincial Commission. These accounts were recorded in the financial reports of local gazetteers. Thus, in Qianlong 5 (1740), Bozhou county 亳州 in Anhui province reported tax payments in silver of 4 liang 1 fen 9 li to pay for calendars.[127] Then, in Qianlong 39 (1774), the amount was raised slightly to 4 liang 8 fen 6 li.[128] In Daoguang 13 (1833), Dingyuan county 定遠, which was also located in Anhui province, reported 8 taels as a total for two administrative levels. The prefecture which oversaw the counties reported 5 taels in silver, while the county reported 3 taels.[129] Further south in Guangdong province, Huazhou county 化州 reported only 1 tael in Qianlong 13 (1748), and Leizhou 雷州 prefecture reported 1 liang 4 qian 2 fen 1 li in Jiaqing 16 (1811).[130]

These allocations varied significantly according to one's geography. In Anhui, Jing county 涇 reported more than 19 liang for its calendar purchases in Jiaqing 24 (1819).[131] Zengcheng county 增城 in Guangdong reported more than 40 liang in Qianlong 19 (1754).[132] Some counties budgeted larger amounts for calendar purchasing and adjusted funds. If they had extra money

[125] *Qin Ding Da Qing Hui Dian (Qianlong) 欽定大清會典* (Wu ying dian, 1764), j. 27, 2a-2b.
[126] Joseph Dennis, *Writing, Publishing, and Reading Local Gazetteers in Imperial China, 1100-1700* (Harvard University Asia Center, 2015), 179-181.; Emily Mokros, *The Peking Gazette in Late Imperial China: State News and Political Authority* (University of Washington Press, 2021), 86-91.
[127] *Bozhou Zhi 亳州志*, Airusheng (1740), j. 3, 190.
[128] *Bozhou Zhi 亳州志*, Airusheng (1774), j. 6, 411.
[129] *Dingyuan Xian Zhi 定遠縣志*, Airusheng (1833), j. 4, 162.
[130] *Hua Zhou Zhi 化州志*, Airusheng (1748), j. 4, 289.; *Lei Zhou Fu Zhi 雷州府志*, Airusheng (1811), j. 5, 814.
[131] *Jing Xian Zhi 涇縣志*, Airusheng (1819), j. 5, 430.
[132] *Zengcheng Xian Zhi 增城縣志*, Airusheng (1754), j. 7, 449.

beyond costs, they could submit it back to the *Buzhengsi*, or use it for additional expenses, such as land reclamation or tribute students.[133]

These funds paid for local commissions, placing calendar production within what Emily Mokros calls the "vernacular" context of administrative printing. It was "vernacular" because it relied on the everyday techniques, raw materials, and resources of local communities.[134] Emily Mokros traces "vernacular" printing through gazettes. With gazettes, regional and local governments contributed to the circulation of these documents, but they did not necessarily prescribe the actual techniques or technologies for publishing. There were at least four different modes of reproduction with gazettes, namely wax-stereotyping, slat printing, scribal copies, and movable-type prints, which all transformed the layout and structure of a gazette and its reading experience. These technologies were associated with regional production. In Beijing, licensed state printers used wax stereotyping. In South China, gazette printers used slat printing.[135] The same edition of a gazette appeared differently depending on one's location and how one had access to the document.

Calendars shared distribution structure and vernacular adjustment to local context. First, although the provincial office was supposed to use the same seal from the Astronomical Bureau to standardize and authorize calendars, surviving examples show that seals varied in practice. For example, the calendar from Qianlong 26 (1761) in the Library of Congress uses an alternative seal. The calendar is printed in high quality ink. It follows the design of standard official prints, and it only contains pages that were related to official calendars. On the front page of the calendar, there is a different seal. The typical seal would have been in Manchu and Chinese. This seal is in red vermillion but it reads: "旬頒監本[斷]正弋字無差" "[This] is an imperial edition according to the appointed time for promulgation. Not a single character is different." The seal (see Figure 1-4) labels the calendar as a *jianben* 監本. This term originally meant an official print based on the Guozijian 國子監 Imperial Academy; but, in late imperial China, the term could refer to others

[133] *Fuyang Xian Zhi 阜陽縣志*, Airusheng (1755), j. 5, 228.; *Yingshang Xian Zhi 潁上縣志*, Airusheng (1753), j. 3, 154.; *Huoqiu Xian Zhi 霍邱縣志*, Airusheng (1774), j. 4, 189; 207.

[134] Emily Mokros, "Chinese Gazettes on the Margins of Book History: Movable Type, Wax Stereotypes, and Vernacular Techniques in Late Imperial China," *Book History* 26, no. 1 (2023): 167-168.

[135] Emily Mokros, "Chinese Gazettes on the Margins of Book History: Movable Type, Wax Stereotypes, and Vernacular Techniques in Late Imperial China," *Book History* 26, no. 1 (2023): 174.

forms of government prints.[136] To summarize, this print appears to be an official printed calendar, but it is likely printed by an individual office rather than one sealed by the Wuying dian.

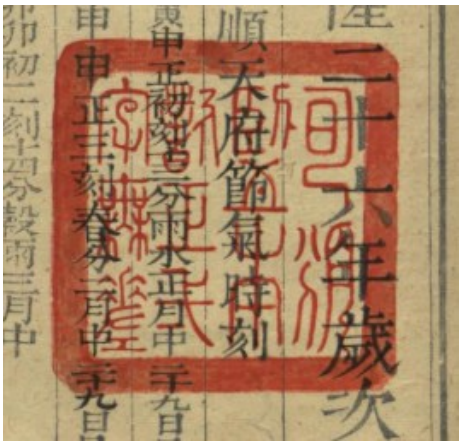


Figure 1-4: Local Official Seal in Calendar. Written in seal script, the text reads 旬頒監本正弍字無差. The text differs from other calendars that use the official seal, stating it has been produced by the Imperial Astronomical Bureau in both Manchu and Chinese. Source: Library of Congress, Chinese Rare Book Collection

Although most calendars are stamped with the seal that bears both Manchu and Chinese, there is another calendar uses the phrase *jianben*. This calendar differs from other calendars in more substantial ways. The calendar is held in the British Library. It is dated to Daoguang 21 (1841), and the calendar appears to be an official calendar with the title *Shixian shu*. But the print contains elements that are not usually found in official prints. It begins with a set of illustrations called the Spring Ox and Herder. These were popular images associated with calendars, but they were not included in the imperial standards, and they were mostly printed with almanacs. The calendar differs in other ways as well. The calendar does not contain the geographic materials that are listed in most standardized calendars, and it does not even provide references for the provinces. It only provides the times of sunrise and sunset for the capital. Most of the booklet is dedicated to the days of the year. The calendar also differs from standard calendars on account of its size. This calendar is nearly half the size of other official calendars. It is far more compact and is only printed with black ink. It does not contain any red pages or annotations.

Despite these differences, the calendar includes official labels and titles claiming to be the *Shixian shu* rather than an almanac. The label repeats the official notice that the calendar was

[136] Wang Guowei, *Wu Dai Liang Song Jian Ben* 五代两宋監本考 (1940; Taiwan shang wu yin shu guan, 1976).

produced by using imperial mathematics, and it contains a seal imprint. The imprint differs from other calendars, insofar as it uses regular style script instead of seal script. While not all of the characters are legible, the final two characters are clear. They report that the calendar is a *jianben* (see Figure 1-5).[137]

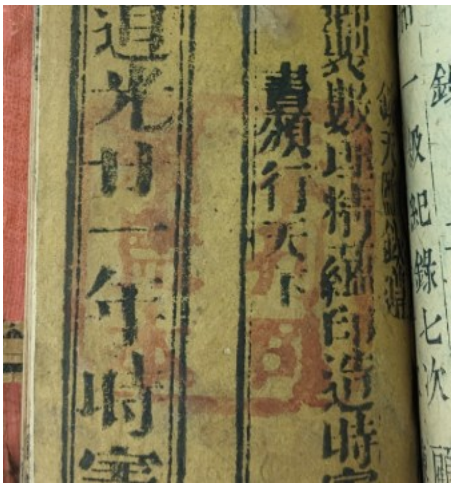


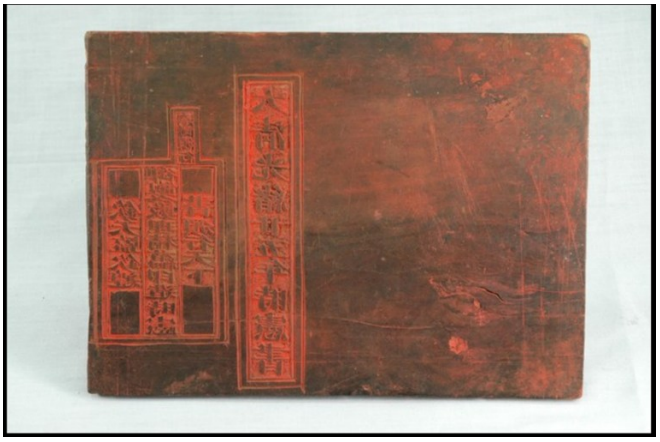
Figure 1-5: Smudged Local Calendar Seal. The red seal contains six characters. The second is 刊 (print) and the final two characters are 監本 (official edition). The character style is unusual. This is a regular *kaiti* 楷體 style calligraphy rather than the more florid seal script of the government office. Source: British Library, 15298.a.6(8)

Some scholars have interpreted these variations as signs that the print was pirated. Chapter 2 discuses pirated calendars and almanacs in greater detail, but the present point is that identifying piracy is difficult because local printing was vernacular in nature. On the one hand, Richard Smith and Carole Morgan have cited the Daoguang 21 calendar from the British Library as one of the most likely examples of a pirated edition.[138] The calendar does contain non-standard elements, and it has features that connected it more closely with the popular almanac tradition. Moreover, the unusual nature of the seal adds to the view that the calendar may have been a pirated copy. But the calendar from the Library of Congress introduces another way to think about the calendar, showing that highly standardized calendars could also contain different forms of seals stating that they were published by local offices. Furthermore, there are other calendars that are more obvious how they

[137] Qintianjian, *Da Qing Daoguang Er Shi Yi Nian Shi Xian Shu 大清道光二十一年時憲書* (1841), 15298.a.6 (8), British Library.
[138] Carole Morgan, "De l'authenticité Des Calendriers Qing," *Journal Asiatique* 271, nos. 3–4 (1983): 378-379. ; Richard J. Smith, *Fortune-Tellers and Philosophers: Divination in Traditional Chinese Society* (Westview Press, 1991), n. 132, 303-304.

violate the standards as pirated. So, for cases like this, it is perhaps more useful to follow Mokros example with gazettes and refer to these variations as vernacular copies. In moving away from the top-down language of official versus unofficial calendars and instead highlighting the situated nature of printing in late imperial China, this way of framing the issue recognizes the heterogeneity of these examples and moves beyond general dichotomies. Marginal cases were not necessarily "pirated" in the sense of completely out of bounds but might be based on more integration within the local printing culture.

While the status of these specific calendars is difficult to determine without additional evidence, other calendar artifacts provide stronger evidence that calendar printing was embedded in vernacular print culture. The National Museum of Taiwan History, for example, has woodblocks that were used in producing regional calendars (see Figure 1-6). One side of the woodblock depicts the date and year of the calendar (i.e. Guangxu 25, 1900). It contains the title which states it is an official calendar *Shixian shu*. It also contains a separate annotation added to the main cover writing that it is an official block that must be followed. The other half of the woodblock however depicts unrelated material. It is a carving for a popular religious print. Although the New Year prints and the illustrations of the Spring Ox could also be considered popular prints, the illustrations here come from unrelated folk narratives and moral literature. From the context of the carver and printer, work orders mattered more than separating official and unofficial content.[139] Blocks like this reflect local culture more than just a top-down view of calendar production.



[139] Unknown, *Guangxu Nian Wu Nian Shi Xian Shu Yi Ji Nei Ye Tu Wen Mu Ke Yin Ban 光緒廿五年時憲書以及內頁圖文木刻印版*, 1899, Wood, 24.2 x 17.7 x 2.4 cm, National Museum of Taiwan History, 2003.008.0798.



Figure 1-6: Woodblock with Calendar and Illustrations. The upper image is the view of the plate with the block print of the *Shixian shu*. The lower image is the view of the plate with the illustrated religious text. Source: Unknown, Woodblock with Guangxu 25 Calendar and Images, 1899, Wood, 24.2 x 17.7 x 2.4 cm, National Museum of Taiwan History, 2003.008.0798

Foreign reports of local calendar printing also attest to this vernacular diversity. Missionaries in South China wrote about calendars, because they were interested in producing their own circulars based on the models of calendars, almanacs, and gazettes.[140] Missionaries noted that pirated editions were common, but they also observed that even official copies varied widely in technology, size, format, and circulation. William Milne (1815-1863), for instance, wrote that there were full and abridged versions. There were also other formats such as pocket editions and sheet almanacs.[141] John Henry Gray (1823-1890) similarly knew that the funds for the print came through the Provincial Treasury. In reproducing calendars, however, the government distinguished between calendars intended for bureaucrats and more "popular" editions available to the general population.[142]

Calendars too belonged to the literature on local technologies as missionaries debated the various affordances of print technologies. William Milne documented different printing technologies in South China. He claimed that calendar seals were produced locally as an example of movable-type. The Chinese and Manchu portions were cast individually and then combined into

[140] For comparison see Anonymous, "Periodical Literature: Chinese Almanacs, Imperial Court Calendar, the Provincial Court Circular of Canton, the Peking Gazette; with Remarks on the Condition of the Press in China," *The Chinese Repository*, 1836.; Richard Turner, "Fourth Annual Report for the Society of the Diffusion of Useful Knowledge in China; Read at a General Meeting, Nov 21st 1838," *The Chinese Repository*, 1838.
[141] William Charles Milne, *Life in China* (G. Routledge and Co., 1857), 137-138.
[142] John Henry Gray, *China: A History of the Laws, Manners and Customs of the People*, vol. 2 (Macmillan and Company, 1878), 15-16.

a single form to create the calendar seal.[143] The woodblocks, however, were primarily used for calendars, because it was a cheaper form of reproduction, and one could recreate it rather quickly in new sites on account of the simple tools that allowed carvers to be mobile.[144]

In addition to such reports, calendars themselves provide indirect evidence for the vernacular context of calendar printing, because commercial businesses partnered with local offices to print calendars on behalf of the government. To meet demand, the government contracted printing with commercial shops. These businesses had established networks for organizing labor and mobilizing resources both in regional and in national levels. The commercial print industry specialized in popular books and educational literature. And commercial printers were one of the main sources in creating private almanacs which constantly bedeviled the state. Contrary to the perspective that the state did not allow private printing, many commercial printers had legal relationships with state offices.

The commercial print industry in Beijing specialized in the production of government prints. Although one of the reasons for this was simply because of proximity to the center, the government also sub-contracted work under predetermined conditions. In order to subvert commercial printers from gathering and publishing information illegally, the government eventually formed a dedicated commercial enterprise called Gongshen tang 公慎堂 that maintained both public and private features.[145] The business was similar to other state-funded commercial partnerships like the pharmacy Tongren tang 同仁堂. These enterprises combined licenses to commercial ventures for public good.[146] Although the Gongshen tang only lasted for about sixty years, commercial printers in Beijing had special relationships with the Wuying dian the official printing office. Some commercial printers were working on behalf of the Wuying dian. And several editions from commercial printers indicate that the printers were allowed to visit the Ministry of Rites or other government offices to access and share woodblocks.[147]

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[143] William Charles Milne, *A Retrospect of the First Ten Years of the Protestant Mission to China* (Anglo-Chinese Press, 1820), 224.
[144] Elijah Coleman Bridgeman, "Chinese Printing," *The Chinese Repository*, 1832.
[145] Emily Mokros, *The Peking Gazette in Late Imperial China: State News and Political Authority* (University of Washington Press, 2021), 41-43.
[146] He Bian, *Know Your Remedies: Pharmacy and Culture in Early Modern China* (Princeton University Press, 2020), 160-164.
[147] Ting Zhang, "Buying and Selling Law Books in Qing Beijing," *East Asian Publishing and Society* 7, no. 2 (2017): 108.

Although historians have emphasized these networks in terms of examination materials and gazettes, the same practice extended to calendars. For instance, one edition of the *Sanyuan jiazi* explicitly mentions its commercial connections. On the frontispiece, beneath the title, the edition states that the original blocks were from the capital editions and that the print is from Liuli chang (i.e. 板藏京都, 琉璃廠).[148] Although the print does not name a commercial house directly, the book shares features of the standard prints from the Wuying dian and names the larger commercial print industry for the area. There is another example which is even more explicit. This calendar, which can be found in the University of California, Berkeley, is called an official calendar, *Shixian shu*.[149] The calendar dates to Guangxu 27 (1900) and is an abridged copy. It only contains time information related to the main provinces, excluding the sections about Mongolia. In addition, the style of the print differs from official prints insofar as the style is squarer. However, it is the front of the calendar that is most revealing. After the cloth red cover, there is a red page frontispiece added before the information in the booklet. It is an advertisement for the printer. The center of the frontispiece contains the stem and branch cycle for the year; and under it is written Tongwen tang 同文堂, the name of the printer. Although this was a relatively common phrase for a print shop making a direct relationship to a specific commercial printer difficult to determine, the notice is striking (see Figure 1-7). The red print is in the style of a dragon frontispiece. Dragon frontispieces were imperial prerogatives.[150] Dragon frontispieces were used in the publication of the law code. But the printer here has added the commercial house in combination with the image. While it is possible that this print shop was one of the same law code print houses, these calendars point to the ways in which access to the blocks created commercial opportunities.[151]

[148] Qintianjian, *Yu Ding San Yuan Jia Zi Wan Nian Shu 御定三元甲子萬年書* (1796-1820), RM c.41.w.1, School of Oriental and African Studies, Morrison collection.
[149] Qintianjian, *Da Qing Guangxu Er Shi Qi Nian Shi Xian Shu 大清光緒二十七年時憲書* (1900), 9315.1901.7, University of California, Berkeley, East Asian Library.
[150] Ting Zhang, *Circulating the Code: Print Media and Legal Knowledge in Qing China* (University of Washington Press, 2020), 32.; Lianxi 翁連溪 Weng, *Qing Dai Nei Fu Ke Shu Yan Jiu 清代內府刻書研究*, vol. 1 (Zi jin cheng chu ban she, 2013), 86.
[151] There is a Tongwen tang from Hangzhou that printed law codes. Ting Zhang, *Circulating the Code: Print Media and Legal Knowledge in Qing China* (University of Washington Press, 2020), 76



Figure 1-7: Dragon Frontispiece. This is the dragon frontispiece for the commercial version of the official calendar. Source: University of California, Berkeley

Certain commercial printers used their access to create localized and innovative transformations of this information. For instance, the Ronglu tang 榮錄堂 was a Beijing commercial printer of the second half of the nineteenth century. They specialized in a new type of store called a *jinshen pu*, an official directory shop. Directory shops sold informational texts of which the most famous were the directories of quarterly updates on government positions. The shops also created city directories or guidebooks to the capital. These new guidebooks provided information about locations of government offices, accommodations, shopping recommendations, and other useful information.[152] One of those categories was festivals and calendars. On the one hand, these calendars were remixed versions of popular religious calendars that listed out birthdays of gods and festivals. These texts had a variety of popular sources, but they were often highly localized for cities and places.[153] The Ronglu tang consequently not only made it local to Beijing, they also added special pages that were linked to imperial fasting days. These features were drawn

[152] Emily Mokros, "Reading the Guides, Directories, Manuals, and Anthologies of Liulichang," *East Asian Publishing and Society* 7, no. 2 (2017): 127–66.
[153] Goossaert, "Periodic Fasting and Religious Calendars in China, 1700–1950."

from the imperial calendars to create relevant lists that were associated with the specific days of a particular calendar year and were meant to provide useful information about the government functions.[154]

These printers also used their connection to create different designs for calendars named as official calendars. In 1888, the same house Ronglu tang published notices in the newspaper that they had were now selling editions of the *Seven Luminaries* calendar, which was targeted to civil and military officials. They wrote that the calendar was based on proper latitude and longitude, and it was mentioned alongside their staple directories.[155] In the late nineteenth century, commercial printers in Shanghai and Tianjin also offered new formats, such as pocket-sized calendars, that they claimed were official. Lithography encouraged them to create a set of new types of directories that combined official calendars with useful information. These works contained official calendars in small sections alongside other useful tables like train timetables, exchange rates, and telegraphy rates.[156]

In sum, local printing added new layers to Qing calendrical infrastructure. Although the state attempted to standardize calendar form through model copies, seals, and regulations, the constraints of local publishing produced variation even in calendars made for civil and military officials. Paper, printing technology, labor availability, and local workshop practice all shaped how calendars were produced. These technologies ranged from movable type and woodblock printing to lithography in the late nineteenth century. In this way, calendar printing shared the broader "vernacular" context that shaped administrative printing more generally. The process became even more transformative when commercial printers became involved. They adapted official calendrical information for local and transregional audiences, combining calendars with directories, festival lists, timetables, exchange rates, and other practical information. Future studies using chemical and material analysis of paper and ink may clarify these differences further. Even

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[154] Shi'an 楊士安 Yang, *Chao Shi Cong Dai 朝市叢載* (1886), 地 110/936-2, National Library of China, j. 1, zhaijie, 1a-10b; jizhen, 11a-13b.

[155] Shen Bao, 1888.11.23, 5; 1888.11.30, 6; 1888.12.21, 8; 1888.12.22, 6

[156] Shen Bao, 1904.2.10, 4; Anonymous, *Tianjin Jiang Xue Zhai Jiao Yin Zeng Guang Wu Xu Sui Guan Shang Kuai Lan Ba Shi Zhong 天津絳雪齋校印增廣戊戌歲官商快覽八十種* (Jiang xue zhai shi yin, 1897), 9315.3097 1898, University of California, Berkeley, East Asian Library.; Anonymous, *Guan Shang Kuai Lan 官商快覽* (1902), 9315.3097 1903, University of California, Berkeley, East Asian Library.; Anonymous, *Wen Bao Zhai Guan Shang Bian Lan Ba Bai Zhong 文寶齋官商便覽八百種.* (Wen bao shu ju, 1907), AY1144 .W46 1909, University of California, Berkeley, East Asian Library. For additional more on these lithographic printers, see Christopher A. Reed, *Gutenberg in Shanghai: Chinese Print Capitalism, 1876-1937* (University of Chicago Press, 2004), 161-202.; Richard Smith, *Chinese Almanacs* (Oxford University Press, 1992), 33-39.

so, the surviving evidence already shows that calendar manufacturing was a complex process involving multiple actors, offices, agencies, and commercial groups working to coordinate and make time accessible.

Distribution

Manufacturing brought together scribes, block carvers, printers, and managers to create calendars that followed formal structures while also allowing for local innovation. Yet production was only one part of the calendrical infrastructure. Calendars also had to be transported across the empire, delivered to officials and readers, and made available through both state and commercial networks. Distribution therefore depended on the Qing state's communication and transportation systems, as well as on local book distributors, traders, and shops. This section first examines the state transportation and communication networks that carried calendars across the empire. It then turns to the traders, booksellers, and market prices that shaped calendar circulation after official distribution.

Logistical Networks

Printing was only one stage in the larger process of transporting calendars. The material infrastructure of calendar distribution overlaid with the military and bureaucratic logistical networks. Two main departments were responsible for sending calendars to provinces and local sites. The Ministry of Rites handled calendars for the emperor and the capital region and oversaw their submission to provincial officials and tributary states. Once calendars arrived in the provinces, provincial officials assumed responsibility for lower-level reproduction, ceremony, and circulation. The second department was the Office of Colonial Affairs. As the office responsible for managing Mongols and other Inner Asian groups, the Lifanyuan was especially involved in sending calendars to frontier sites.

At a high level, the distribution process occurred in the following manner:

1. The calendar department of the Qintianjian finalized the calculations for the following year's calendar within the last two months through the first month of the New Year. Once they completed their calculations, they had to submit their draft to the emperor by the first day of the second month.

2. On the first day of the second month, the emperor reviewed the draft. He usually approved the draft within a few days. Once approved, notifications would be sent to the Ministry of Rites to start preparing the distribution to the provinces and tributary states like Korea and Vietnam.
3. Then, the imperial draft became the source for translations and tailoring to the different types of calendars. The Qintianjian prepared translations into Manchu and Mongolian. They also started working on the distinctions between the imperial editions and the popular editions, which required collaboration between the calendar department and the office of astrological signs. These calculations would result in a set of calendar models which would then be submitted to the Wuyingdian for preparation and printing.
4. First the Wuyingdian had to create two sets of master copies for all three languages of the calendars used for distribution. One set of copies received the stamp from the imperial astronomical bureau while the second copy did not. This second copy was supposed to be the calendar model sent to the provincial government office for duplication.
5. By the first day of the fourth month, the Wuying dian was supposed to have completed the master copies of the next year's calendar. On this day, they sent the master copies through the military postal service to each *Buzhengsi*.
6. Starting from Qianlong 2 (1737), the government added another check for the fifth to sixth months. By this time, the master copies needed to be sent to the frontier in Amdo and Qinghai.[157]
7. Next, after the Ministry of Rites submitted unsealed models to the Buzhengsi, then the Wuyingdian started to print the required quotas for the capital region and government. The Wuyingdian was responsible for producing all the copies used by the emperor, the royal family, and ministers of the court. It was also responsible for producing all the copies for the garrisons and military officials, including Chinese, Manchu, and Mongolian offices. The central government took on the responsibility to print copies for the capital region. Furthermore, starting from the early Yongzheng reign, when the provinces of Heilongjiang and Jilin were added, the capital took on the responsibility to provide calendars for this region instead of sending models for governors to manage.[158]

[157] *Qin Ding Da Qing Hui Dian Ze Li 欽定大清會典則例*, SKQS (1764), j. 62, 5a-5b.
[158] *Qin Ding Da Qing Hui Dian Ze Li 欽定大清會典則例*, SKQS (1764), j. 158, 4a-5b.

8. At the same time as the Wuyingdian printed these thousands of copies, each provincial office began to coordinate with local printers to share master copies with districts for additional administrative and large-scale printing.[159]
9. In addition, during the period from the fourth month to the tenth month, civil and military officials could submit individual requests to the Wuying dian to order more calendars than were already in the planned requisitions.
10. By the first day of the tenth month, printing was supposed to be completed as the printers needed to submit the copies to each of the administrative offices where the emperor and provincial governor would conduct the ceremony for receiving the calendar. Only after the ceremony could government officials allow the circulation of the calendars and the distribution of the new calendars to various bookstores.
11. On the third day of the tenth month, central institutions, such as the Ministry of Rites and the Lifanyuan, were then allowed to carry out shipments. Starting from this day, they sent the prepared copies to all of the sites under the government's responsibility.
12. Form the tenth month to the twelfth month, bookstores received shipments of calendars and started to distribute them to wholesalers who brought them to other smaller scale shops.[160]

This framework is a useful model for understanding the flow of calendars from production to distribution throughout the year (see Figure 1-8). It consequently rested upon the rise of physical delivery services and postal networks that carried these information packets across the empire and delivered the actual packages to various destinations by the appropriate time.

[159] *Qin Ding Da Qing Hui Dian (Qianlong) 欽定大清會典* (Wu ying dian, 1764), j. 27, 2a.
[160] Compiled from *Qin Ding Da Qing Hui Dian (Qianlong) 欽定大清會典* (Wu ying dian, 1764), j. 27, 1a-2b; *Qin Ding Da Qing Hui Dian Ze Li 欽定大清會典則例*, SKQS (1764), j. 158, 4a-5b.; Rongzheng 張榮錚 Zhang, ed., *Qin Ding Li Fan Bu Ze Li 欽定理藩部則例* (Tianjin gu ji chu ban she, 1998), j. 23, 3a-4b.

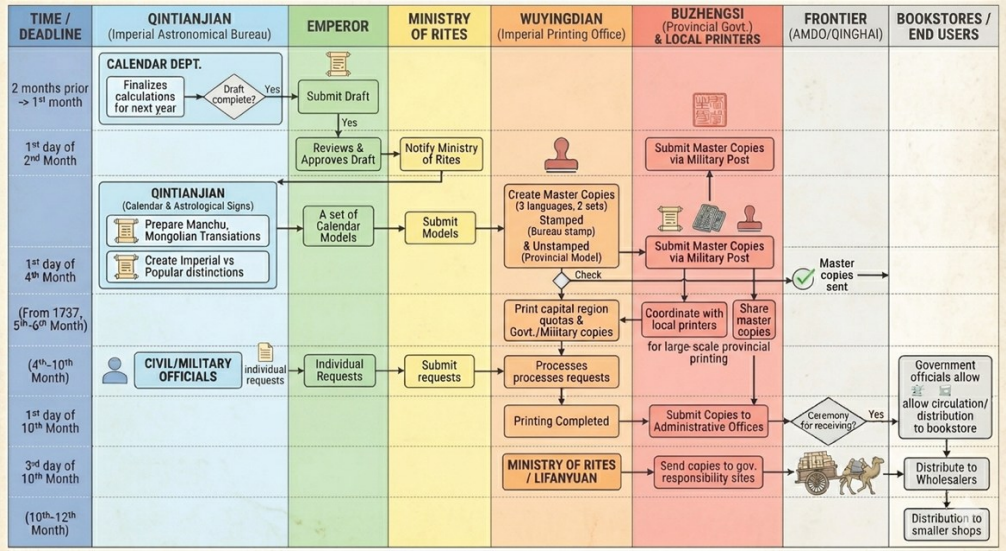

Figure 1-8: Flow of calendars. Source: Author, made with Gemini.

This postal network overlapped with military relay stations. There were five main routes that connected the capital to different regions: 1) northeastern route (Beijing → Mukden/Shengjing → Jilin → Heilongjiang); 2) eastern route (option 1: Beijing → Shandong → Anhui → Jiangxi → Guangdong; option 2: Beijing → Shandong → Jiangsu → Zhejiang → Fujian); 3) central route (option 1: Beijing → Henan → Hubei → Hunan → Guangxi; option 2: Beijing → Henan → Guizhou → Yunnan); 4) western route (option 1: Beijing → Shanxi → Shaanxi → Gansu → Xinjiang; option 2: Beijing → Shanxi → Shaanxi → Sichuan → Tibet); 5) northwestern route (Beijing → Kalgan → Urga → Uliastai → Khovd).[161] These transportation routes also contained sub-branches for further communication. They had internal circulation within provinces, and they had multiple sets of relay stations and way stations as supplies on the route.

[161] John K. Fairbank and Ssu-yu Teng, "On The Transmission of Ch'ing Documents," *Harvard Journal of Asiatic Studies* 4, no. 1 (1939): 15.; Silas H. L. Wu, *Communication and Imperial Control in China: Evolution of the Palace Memorial System, 1693–1735* (Harvard University Press, 1970), 28.

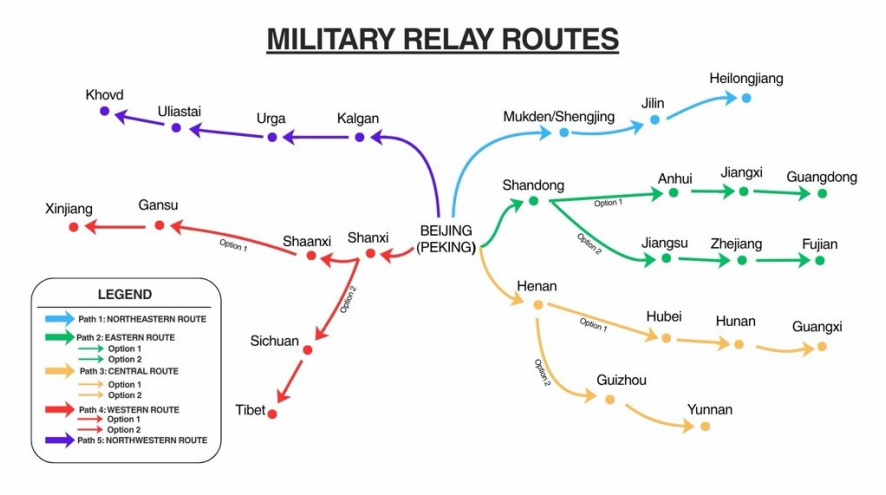

Figure 1-9: Visualization of Military Relay Routes. Credit: Israel Shriki

These communication networks functioned as the arteries and veins of the empire.[162] They provided ongoing notifications about communication, but they were also important in delivering physical packages. The network was restricted to government use, but it had several sets of hierarchies. There were special regulations for emergency communications which required fast responses, and there were restrictions on certain types of materials transported in the system. But the network could move large packages, such as tax collected materials.[163] These items had to be securely packaged, and they were then transported through various means. Those means included porters, pack animals, carriages, and boats. The system required significant amounts of maintenance and upkeep.[164]

While historians have typically studied these networks from the lens of security and surveillance, the bureaucratic network of communications was also how calendars were transmitted to local society. The Qing period was an innovative moment in the history of communications because the Qing both adapted earlier models from the Yuan and the Ming and created new forms of communication and transportation that tried to eliminate certain barriers. In

[162] Lane J. Harris, "The 'Arteries and Veins' of the Imperial Body: The Nature of the Relay and Post Station Systems in the Ming Dynasty, 1368–1644," *Journal of Early Modern History* 19, no. 4 (2015): 287–310.
[163] John K. Fairbank and Ssu-yu Teng, "On The Transmission of Ch'ing Documents," *Harvard Journal of Asiatic Studies* 4, no. 1 (1939): 19.
[164] Ying-Wan Cheng, *Postal Communication in China and Its Modernization, 1860-1896* (Harvard University Asia Center, 1970); Lane J. Harris, "The Post Office and State Formation in Modern China, 1896-1949" (Phd Dissertation, University of Illinois, Urbana-Champaign, 2012); Weipin Tsai, *The Making of China's Post Office: Sovereignty, Modernization, and the Connection of a Nation* (Harvard University Asia Center, 2024).

an attempt to increase the speed of information and reduce the leakage of information, early Qing emperors created new protocols that circumvented older institutions for routine documents. Whereas routine memorials had to be copied and submitted for review, which could lead to delays, the new secret palace memorials functioned at a more personal level, as high-ranking officials were able to use private couriers to send the documents to the capital where they were then picked up by palace servants who reported them immediately to the emperor and his cabinet. The information could then move in the opposite direction as the emperor sent out his own missives in response. By the late eighteenth century, this second-level network also became routine and developed its own growing structure for managing and controlling documents. This innovation is one of the important institutional features that shaped how information moved between the court and provinces.[165]

Administrative procedures controlled these documents, and these procedures had physical and material forms. There were different types of containers used for transportation. In the case of palace memorials, for instance, the documents were enclosed in a white wrapping with the name and seal of the sender. Inside the wrapping was a wax-sealed envelope with additional labels.[166] During transportation, these memorials were placed inside "memorial caskets" (see Figure 1-10). These were boxes made from light wood and covered in yellow cloth. If the boxes were unavailable, the documents were placed between wooden boards and were latched together with yellow coverings.[167] In addition to the wooden boxes, there were also other types of containers, such as leather wrapping containers (see Figure 1-11).[168]

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[165] For additional detail on the changes in the system, see Fairbank and Teng, "On The Transmission of Ch'ing Documents"; John K. Fairbank and Ssu-yu Teng, "On the Types and Uses of Ch'ing Documents," *Harvard Journal of Asiatic Studies* 5, no. 1 (1940): 1–71; Wu, *Communication and Imperial Control in China*; Beatrice S. Bartlett, *Monarchs and Ministers: The Grand Council in Mid-Ch'ing China, 1723-1820* (University of California Press, 1991); Maura D. Dykstra, *Uncertainty in the Empire of Routine: The Administrative Revolution of the Eighteenth-Century Qing State* (Harvard University Asia Center, 2022).

[166] Jonathan D. Spence, *Ts'ao Yin and the K'ang-Hsi Emperor: Bondservant and Master* (Yale University Press, 1988), 220.; Mark C. Elliott, "The Manchu-Language Archives of the Qing Dynasty and the Origins of the Palace Memorial System," *Late Imperial China* 22, no. 1 (2001): 47.

[167] Beatrice S. Bartlett, "Ch'ing Palace Memorials in the Archives of the National Palace Museum," *The National Palace Museum Bulletin* 13, no. 6 (1979): 5.

[168] *Container for Memorials in Red Lacquered Leather* 红漆皮奏折匣, Early Qing, Leather, 30 x 15 x 6.8 cm, Beijing Palace Museum, 故 00181305-8/46.

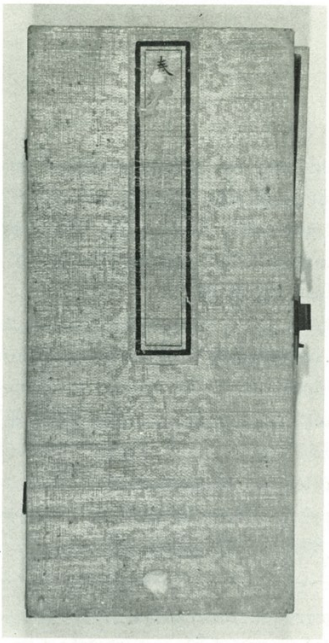

Figure 1-10: Memorial Casket. This top-down view of a memorial casket could contain one or more memorials for transport. Source: Ch'ing Palace Memorials, fig. 1.

As a bureaucratic document, calendars moved through this same material practice of control. Calendars were not palace memorials or secret memorials. They were, however, routine administrative documents that followed the document procedures attached to government forms and documents. Calendars were subject to these same kinds of information protocols that distinguished documents like memorials from routine reports. Accordingly, once the calendar models and prints were prepared, they had to be packaged and shipped through the same system that sent communication documents from the capital to the different nodes in the empire. Generally, this meant that calendars flowed through all the steps of document control rather than the more expedited movement associated with secret palace memorials. There were also special regulations that treated just calendars alone. Calendars had to be transmitted in special containers or bamboo cages that were designed for transporting large, bulky packages.[169] For calendars that were sent to Mongolia, these too had to be covered in white felt and protected for transport.[170]

[169] *Qin Ding Da Qing Hui Dian Ze Li 欽定大清會典則例*, SKQS (1764), j. 158, 9a-9b

[170] Zhang Rongzheng, ed., *Qin Ding Li Fan Bu Ze Li 欽定理藩部則例* (Tianjin gu ji chu ban she, 1998), j. 23, 4a.



Figure 1-11: Memorial Container. This is wrapper for documents made from red-lacquered leather. Source: Beijing Palace Museum, 故 00181305-8/46

The people responsible for transporting these packages and getting them to the right places were administrative middlemen called the *titang guan* 提塘官 or "communications liaisons."[171] Communications liaisons managed the flow of documents rather than the actual network itself. Postal infrastructure came under the management of a separate set of offices called the "postal circuit intendants" *yidao* 驛道 and "local postmasters" *yicheng* 驛丞. These figures were the ones responsible for maintaining supply lines and couriers. They ensured that there were enough horses at stations for instance. Although *in practice* communications liaisons ended up managing postal couriers and had oversight in this area, their role was primarily about recording when documents arrived at a government site, recording how they arrived, and determining where to send the relevant documents. In other words, they assembled various sets of documents and transmitted them in larger packets.[172]

During the Qing dynasty, communications liaisons operated at three levels: capital, provincial, and military garrison. Capital communications liaisons or *zhujing titang guan* 駐京提塘官 controlled the flow of documents and packages between the inner court and the outer court. There were sixteen positions that represented each of the different provincial and regional units for where the office needed to transmit the documents. Provincial communications liaisons or

[171] Liu Wenpeng, "Qing Dai Ti Tang Kao 清代提塘考," *Qing Shi Yan Jiu*, no. 4 (2007): 87–91.; Emily Mokros, "Spies and Postmen: Communications Liaisons and the Evolution of the Qing Bureaucracy," *Frontiers of History in China* 14, no. 1 (2019): 19–50.
[172] Emily Mokros, "Spies and Postmen: Communications Liaisons and the Evolution of the Qing Bureaucracy," *Frontiers of History in China* 14, no. 1 (2019): 23-24.

zhusheng titang 駐省提塘 were based in the provincial seat. These figures communicated with the capital liaisons both receiving capital packets and organizing the sending of packets to the capital. Provincial liaisons were also the figures who retransmitted and organized the movement of documents from the provincial center down to the district. The third type, garrison communications liaisons *titang* 提塘, managed military intelligence. They reported to both the provincial and to the capital liaisons.[173]

Liaisons tracked times for documents as they were responsible for sending and delivering packages in a timely manner. The government had expectations about delivery times. The offices recorded the date and hour when they sent and received packages. They used this information to evaluate liaisons who could be punished if delivery times did not meet expectations. Using official measurements in terms of li, there were standard rates for these delivery times. Packages ranged from routine to emergency, and they were distinguished according to travel by foot versus travel by horse. Routine transmissions were supposed to be done with foot couriers rather than by horse. Time rates for the two transportation methods differed widely. For instance, communication with Yili, one of the furthest cities in the empire, was expected to take nearly 200 days by foot and more than 40 days by horse. Time rates for Guangzhou included nearly 60 days by foot and 32 days by horse.[174]

These times impacted the movement of calendars, because calendar production operated on fixed schedules. Although provincial materials were shipped by the fourth and fifth months so that the provincial treasury could coordinate the printing for provincial administration, the office in Beijing remained responsible for all military publications. This remained an important and large volume set of orders, because military publication encompassed all three languages of Chinese, Manchu, and Mongolian. Moreover, these packages could not be sent until after the official ceremony which occurred on the first day of the tenth month. While there were military garrisons in the central provinces, many of the military sites related to Manchu and Mongolian, such as Yili, were among the most distant locations in the empire (see Figure 1-12).[175] This meant that capital

[173] Emily Mokros, "Spies and Postmen: Communications Liaisons and the Evolution of the Qing Bureaucracy," *Frontiers of History in China* 14, no. 1 (2019): 22-23.; Emily Mokros, *The Peking Gazette in Late Imperial China: State News and Political Authority* (University of Washington Press, 2021), 36-37.
[174] John K. Fairbank and Ssu-yu Teng, "On The Transmission of Ch'ing Documents," *Harvard Journal of Asiatic Studies* 4, no. 1 (1939): 21-29.
[175] For overviews of Manchu cities in the empire, see Mark C. Elliott, *The Manchu Way: The Eight Banners and Ethnic Identity in Late Imperial China* (Stanford University Press, 2001), 93-98.

liaisons had to submit calendar packages as quickly as possible in the first days of the tenth month if they were going to meet standard delivery times.

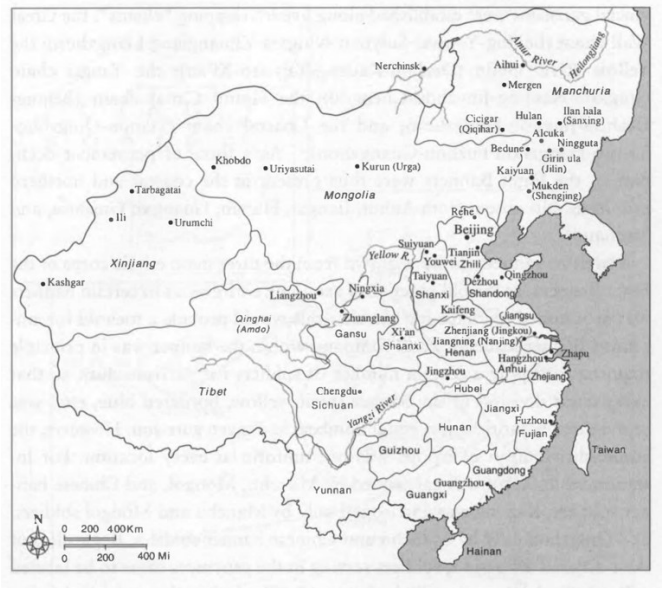

Figure 1-12: Manchu Garrisons in the Empire. These are the main garrisons in the empire at the height of the eighteenth century. Source: Manchu Way, 95, Map 2.

Moreover, these were bulky packages, which is why they were prepared in larger containers than memorial boxes. They contained large numbers of calendars. Official records state that several thousand calendars had to be printed just for the capital area alone.[176] Calendars to Inner and Outer Mongolia consisted of another 3000 prints.[177] The garrison at Yili also received several hundred calendars that were distributed throughout Mongolian banners.[178]

Internal documents also speak to the trouble with handling these large numbers and trying to get them out. In Qianlong 5 (1740), for instance, the Directors of the Astronomical Bureau requested the emperor to give relief on the size of the orders. They had requisitioned almost 730,000 sheets of paper for the previous year's printing and had produced 72,400 copies of the

[176] *Qin Ding Da Qing Hui Dian Ze Li 欽定大清會典則例*, SKQS (1764), j. 158, 5a.
[177] Zhang Rongzheng, ed., *Qin Ding Li Fan Bu Ze Li 欽定理藩部則例* (Tianjin gu ji chu ban she, 1998), j. 23, 3a-3b.
[178] Zhang Rongzheng, ed., *Qin Ding Li Fan Bu Ze Li 欽定理藩部則例* (Tianjin gu ji chu ban she, 1998), j. 23, 3b-4a.

calendar for all the bannermen.[179] These numbers were viewed as unsustainable for distributing and making deliveries.

Calendar deliveries were deeply embedded in the physical geography of the empire. Transportation infrastructure enabled the Qing state to circulate standardized calendars across vast distances, but this same infrastructure also faced material constraints. Some constraints arose from transportation methods, while others resulted from the size and bulk of calendar shipments. Because calendars were routine documents, they were supposed to be handled by foot couriers, even when they traveled in large bundles. The movement of documents through the empire also had a social dimension, as communications liaisons controlled access to and the flow of official packets. The final section on frictions returns to these constraints in greater detail. For now, the discussion continues with the next layer of distribution: local book distributors and shops.

Bookstores, Temples, and Hawkers

Once calendars left official postal networks, they entered a seasonal marketplace shaped by temples, bookstores, street hawkers, village intermediaries, and low prices. Because they marked the coming year, they were supposed to appear on the market only near the end of the current year. Compared with other types of books, calendars were therefore subject to stricter temporal regulation: distributors could sell them only after the official calendar ceremony. In this sense, the appearance of calendars in the market functioned like seasonal foods and clothing. It signaled the approach of winter, the end of the year, and preparations for the New Year.

Foreign observers remarked on the seasonality of calendar sales. The purchasing of a new calendar was a part of the transition to winter and preparation for the new year. In a report on periodicals, the Society for the Diffusion of Useful Knowledge in China commented on this seasonality in Guangzhou. They noted that calendars, or what they interchangeably called almanacs, started to appear in markets at the end of the year and the beginning of the new year.[180] William Milne made similar observations about life in Shanghai in the 1840s and 1850s. He was invited to the homes of friends for the Chinese New Year. As a part of his description about foods, rituals, and everyday life during this season, he added that new calendar purchases were a popular

[179] Imperial Astronomical Directors, "019954," Palace Memorial, QL 5/2, Grand Secretariat Neige daku dang'an.
[180] Richard Turner, "Fourth Annual Report for the Society of the Diffusion of Useful Knowledge in China; Read at a General Meeting, Nov 21st 1838," *The Chinese Repository*, 1838, 399-400.

activity to prepare for the New Year. It was during this season that calendars were the most popular work circulated in bookstores and markets: nearly every shop clerk had some kind of calendar available for purchase.[181] Other writers, including Alfred Lister (? -1890) and Alvin Pierson Parker (1850-1924) also wrote about the purchasing of calendars at this season.[182]

After the calendar ceremony, local governments designated public spaces as distribution centers where bookstores could collect bulk orders. Late Qing newspaper reports from Jiangsu, which provide clear evidence on distribution centers, demonstrate that the provincial government in Suzhou initially chose local temples as primary distribution centers. The government made calendars available at the Yuandu Temple 元都觀 and the Yuanmiao Temple 圓妙觀.[183] Although some shops were able to go to these sites to purchase, some districts also created secondary distribution sites. In Shanghai, for instance, the local government helped transport calendars from Suzhou and established another distribution center at the City God Temple.[184] These sites were typically located near the government office and were publicly accessible.

Although the government provided individual calendars for officials as a part of the ceremonies, the general populace accessed calendars through bookshops. The distribution centers served bookstores and book agents. These stores collected larger orders and then sold them to individuals. For instance, Alvin Parker stated that certain bookstores were "authorized" stores that had relationships with the government. These stores collected the calendars and kept them on sale until the third month of the following year. At this time, they had to surrender the remaining supply, because these extra calendars were collected and burned.[185] This practice may have been related to the submission of new calendar models in the fourth month, and officials did not want outdated calendars from the previous year to continue circulating.

Although foreign observers provide some of the richest details about these aspects of social life, Chinese writers occasionally commented on these book sellers and markets. For instance, a Mr. Zhang from Suzhou wrote an object poem in praise of the imperial calendar. In the poem, he described the calendar as coming from the palace and becoming available in bookshops posted

[181] William Charles Milne, *Life in China* (G. Routledge and Co., 1857), 135.
[182] Alfred Lister, "Chinese Almanacs," *The China Review*, 1873 1872, 239; Alvin Pierson Parker, "The Chinese Almanac," *The Chinese Recorder and Missionary Journal*, 1888, 64-65.
[183] Shen Bao, 1882.11.29, 2; Shen Bao, 1894.11.14, 4
[184] Shen Bao, 1890.12.1, 3; Shen Bao, 1894.11.14, 4; Shen Bao, 1894.11.26, 3
[185] Alvin Pierson Parker, "The Chinese Almanac," *The Chinese Recorder and Missionary Journal*, 1888, 65.

with its black and red ink.[186] The writer Gu Lu 顧祿 (1793-1843) also wrote about purchasing calendars from bookshops during the winter. In his collection of local customs about Suzhou, he wrote that calendar purchasing was a popular activity in preparation for the New Year. When he wished to buy his calendar for the upcoming year, he visited bookstores in Suzhou's Chang-Xu 閶胥 neighborhoods where shops hung the books for sale.[187] These neighborhoods were well-known for their commercial books. This was the same place that produced woodblock prints and other popular literature.[188]

Calendars belonged to the category of popular prints and therefore circulated outside of bookstores as a part of the itinerant shops.[189] The book trade encompassed multiple markets from luxury books down to cheap, popular prints. The popular market included various genres, including poems, songs, drama, theater, and, of course, almanacs.[190] Merchants who specialized in these markets did not always operate physical bookstores. Many set up temporary book stalls or laid books out on the street.[191] Images of urban street sellers included not just popular book sellers, but specific calendar merchants who could be found in urban centers (see Figure 1-13).[192] In the literature on official calendars and private almanacs, foreign observers described these merchants as street hawkers. They shouted about the sale of new almanacs during this season. They preferred to call these objects *sheng* 勝 rather than *shu* 書, because *shu* was homophonous

[186] Gu Lu, *Qing Jia Lu 清嘉錄*, vol. 1262, Xuxiu Siku Quanshu 續修四庫全書 (1820), j. 12, 6b-7a, 807.
[187] Gu Lu, *Qing Jia Lu 清嘉錄*, vol. 1262, Xuxiu Siku Quanshu 續修四庫全書 (1820), j. 12, 6a-6b, 807.
[188] John Lust, *Chinese Popular Prints* (Brill, 1996), 48-66; Ellen Johnston Laing, "Eighteenth Century Suzhou Prints and the Iconography of Wealth," in *Handbook of the Colour Print in China 1600-1800*, ed. Anne Farrer and Kevin McLoughlin (Brill, 2022); Cheng-Hua Wang, "Production and Commoditisation of Suzhou Single-Sheet Prints in the Early and Mid-Qing Dynasty with a Special Focus on Cityscapes," in *Handbook of the Colour Print in China 1600-1800*, ed. Anne Farrer and Kevin McLoughlin (Brill, 2022).
[189] For a description of this book trade, see Fan Wang, "The Distant Sound of Book Boats: The Itinerant Book Trade in Jiangnan from the Sixteenth to the Nineteenth Centuries," *Late Imperial China* 39, no. 2 (2018): 17–58.
[190] Lucille Chia, *Printing for Profit: The Commercial Publishers of Jianyang, Fujian (11th–17th Centuries)* (Harvard University Asia Center, 2003), 126-141, 220-250.; Cynthia J. Brokaw, *Commerce in Culture: The Sibao Book Trade in the Qing and Republican Periods* (Harvard University Asia Center, 2007), 305-320.; Joan Judge, *The Politics of Common Reading: Vernacular Knowledge and Everyday Technics in China, 1894-1954* (University of Chicago Press, 2025), 63-94.
[191] Elijah Coleman Bridgeman, *Description of the City of Canton: With an Appendix, Containing an Account of the Population of the Chinese Empire, Chinese Weights and Measures, and the Imports and Exports of Canton* (The Chinese Repository, 1834), 46-47. Compare Joan Judge, *The Politics of Common Reading: Vernacular Knowledge and Everyday Technics in China, 1894-1954* (University of Chicago Press, 2025), 95-132.
[192] Anonymous, *Ein Kalenderhändler*, 19th century, Paper, Water-color, 30,2 x 23,7 cm, Albertina, Vienna, 14026.

with *shu* 輸 meaning to lose or to be defeated. So, they used *sheng*, meaning "victory", to promote good luck for the new year.[193]



Figure 1-13: Calendar Merchant. This illustration comes from an album of 100 paintings about merchants and laborers in 19th century China. Source: Anonymous, Ein Kalenderhändler, 19th century, Paper, Water-color, 30,2 x 23,7 cm, Albertina, Vienna, 14026.

Although bookstores and hawkers helped circulate these prints to urban consumers, additional intermediaries were involved in circulating calendars to rural centers far beyond government centers. According to Gu Lu, there were some calendar merchants who sold state calendars to villages. The provincial government ensured that calendars were available only at the district level. It did not provide subdistrict level circulation. Villages required calendrical information, but many villages purchased single-sheet calendars instead of official calendars.[194]

[193] C. F. P., "Notes," *The China Review*, 1873 1872, 62.; Alfred Lister, "Chinese Almanacs," *The China Review*, 1873 1872, 257.

[194] Single-sheet calendars had a long history, which I am not discussing here, because my primary focus is on state calendars. For more on these prints, see Ellen Johnston Laing, *Selling Happiness: Calendar Posters and Visual Culture in Early-Twentieth-Century Shanghai* (University of Hawai'i Press, 2004), 20-28.; James A. Flath, *The Cult of Happiness: Nianhua, Art, and History in Rural North China* (University of Washington Press, 2004). Single-sheet calendars were connected to New Years traditions. Basic lists of calendar days were included on almost all prints of the Kitchen God, a major part of popular life during the New Year. For more see Sung-lien Po and David Johnson, *Domesticated Deities and Auspicious Emblems: The Iconography of Everyday Life in Village China* (Chinese

But in Jiangsu province, this did not mean that villages were removed from official calendars. Village elders or rather literate individuals from villages would travel to urban districts during the winter season to purchase state calendars that they would then carry back to the village. Although Gu Lu did not know when the practice had started, the point is revealing about the mechanisms by which state calendars could still have power over rural village life.[195] Since literate village elders were frequently the ritual specialists for their village as well as their neighboring market towns, these purchases guaranteed that while only a small number of people in a village might have had access to an official calendar, these were the most important leaders in rural community life who managed major events concerning time, such as births, burials, and marriages.

Yamen runners might also serve in this capacity. In North China, Li Guangting 李光庭 (1812-1880) wrote that yamen runners and lower-level official staff were the intermediaries for this lower level of distribution. During the distribution, these lower-level officials offered to print additional versions of the calendar for gentry. He wrote most villagers had versions of the calendars in their images of the Kitchen Stove god, and they were less interested in using the official books. But during the distribution, the yamen runners would try to convince people to buy state calendars. They warned that if a family conflict or divorce led the household to tear apart the Kitchen God image, the family would no longer have access to the calendar information printed on it. By that time, it would be too late to consult auspicious dates in the almanac.[196]

Market Prices

Calendar redistribution was possible at this scale because demand was high and prices were low. State calendars were not free, but they were affordable, and the government tried to maintain those low prices.

Popular Culture Project, 1992), 23-59.; Ellen Johnston Laing, *Divine Rule and Earthly Bliss: Popular Chinese Prints; The Collection of Gerd and Lottie Wallenstein* (Museum für Asiatische Kunst, 2010), 176-185.; Robert L. Chard, "Rituals and Scripture of the Stove Cult," in *Ritual and Scripture in Chinese Popular Religion: Five Studies*, ed. David Johnson (Chinese Popular Culture Project, 1995).

[195] Gu Lu, *Qing Jia Lu* 清嘉錄, vol. 1262, Xuxiu Siku Quanshu 續修四庫全書 (1820), j. 12, 6b-7a, 807.

[196] Li Guangting, *Xiang Yan Jie Yi* 鄉言解頤 (Zhonghua shu ju, 1982), j. 4, 15a-15b, 65.

The government generally priced its books according to production costs. Price records from the circulation office of the Wuying dian attest to these low costs.[197] These accounts show that most books reflected the cost of production.[198] The bureau calculated the material costs of paper, ink, and labor and used this to standardize the cost of the books. If a book had more volumes and used higher-quality paper, then the price reflected that.[199] The astronomical textbooks, for example, cost less than 1 tael. The mathematics textbooks, on the other hand, included high-quality illustrations, and could cost as much as 2.6 taels. While records indicate that most people did not order actual calendars from the Circulation Bureau, they did order the handbooks that were used in the construction of these calendars, which were only listed at 0.5 taels.[200]

Other sources also indicate that the government tried to keep calendar prices low. Calendar prices were debated several times in the early Qing. By the end of the Yongzheng reign, prices were fixed even for private merchants selling calendars on behalf of the government. The maximum price for a calendar was set at 0.12 taels.[201]

Foreign visitors also claimed that calendars and almanacs were among the cheapest books available. One price reference from the early nineteenth century in Guangzhou claimed that local almanacs were sold for $8 per 100 copies. In other words, calendar books were sold closer to 0.08 taels, less than the prices stated in the official sources.[202] William Milne in the 1850s said that the calendars were available at any stall, and they were a small cost at "three farthings" or just a "penny".[203] Alfred Lister also said that he purchased his calendar for just a few "halfpence". [204]

One of the best sources for actual calendar costs is Li Ciming 李慈銘 (1830-1894). In his diaries, Li recorded personal expenses throughout the year. These records included general expenses, i.e. paper, medicine, and books. Among the books, he recorded several calendar

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[197] Xiang Xuan, "Qing Dai Dian Ben Shuo Mai Liu Tong Kao Shu 清代殿本售賣流通考述," *Shi Xue Yue Kan*, no. 10 (2018): 22–32.; Ting Zhang, *Circulating the Code: Print Media and Legal Knowledge in Qing China* (University of Washington Press, 2020), 22-28.

[198] Weng Lianxi, *Qing Nei Fu Ke Shu Dang an Shi Liao Hui Bian 清内府刻書檔案史料彙編* (Guang ling shu she, 2007), 105-139.; Xiang Xuan, "Qing Dai Dian Ben Shuo Mai Liu Tong Kao Shu 清代殿本售賣流通考述," *Shi Xue Yue Kan*, no. 10 (2018): 25

[199] Ting Zhang, *Circulating the Code: Print Media and Legal Knowledge in Qing China* (University of Washington Press, 2020), 27-28.

[200] Weng Lianxi, *Qing Nei Fu Ke Shu Dang an Shi Liao Hui Bian 清内府刻書檔案史料彙編* (Guang ling shu she, 2007),. 650-663, 689-721

[201] *Qin Ding Da Qing Hui Dian Ze Li 欽定大清會典則例*, SKQS (1764), j. 62, 4b.

[202] Elijah Coleman Bridgeman, "Chinese Printing," *The Chinese Repository*, 1832, 422.

[203] William Charles Milne, *Life in China* (G. Routledge and Co., 1857), 139.

[204] Alfred Lister, "Chinese Almanacs," *The China Review*, 1873 1872, 239

purchases. The cheapest calendar cost 400 *wen* from 1876, and the most expensive was a calendar from 1882 at 1,300 *wen*. Although Li usually listed calendars as a single purchase, he occasionally bought a calendar jointly with other informational texts. Thus, in 1881, he paid 5,000 *wen* in total for a purchase of both a calendar for the new year and a directory of recent appointments.[205]

These prices show that calendars occupied an unusual position in the book market. They were official documents, but they were also inexpensive seasonal commodities. Their low cost allowed them to move through bookstores, temples, hawkers, village elders, and yamen runners, extending state calendrical information far beyond the formal ceremony.

Use

Calendar materiality did not end with design, production, or distribution. It also shaped how people used calendars in ritual, administration, and everyday life. Calendar artifacts helped structure state ceremonies, and they guided private and individual choices about time. They served as references for checking dates, seasonal transitions, and auspicious moments, while also providing surfaces on which users could record and mark time. By interacting with these material objects, individuals participated in the broader project of state time while adapting calendars to personal, household, and local needs. Together, these practices created overlapping networks of temporality.

Scheduling

State calendars were essential tools for scheduling public and private rituals. Although this function may seem obvious, it was central to the calendar's social and political importance. Once individuals possessed calendars based on the state calendar, these artifacts served as devices for ordering annual events. Many of these events were public affairs: performances of government authority that reinforced the legitimacy and status of the state. They had repercussions for organizing life beyond public ceremony. Calendar dates and seasonal events were significant in the world of private and domestic rituals. Seasonal transitions had implications for every member of society. They impacted daily life across almost all parts of the Chinese empire. At smaller scales, lists of auspicious days and times informed the scheduling of many daily activities. Calendars were integral to the functioning of daily life and guiding choices for future actions.

[205] Zhang Dechang, *Qing Ji Yi Ge Jing Guan de Sheng Huo 清季一個京官的生活* (Xianggang Zhong wen da xue, 1970). 106, 161, 170, 183, 187

State calendars were particularly significant in coordinating different scales of public life. Calendar designs varied according to their intended audiences. Emperors had some of the most elaborate tables and content, although popular calendars were also important at organizing life. Yet certain astronomical events cut across these categories. They became important markers that allowed for coordination across social differences. These events marked larger scale transitions throughout the year and required collaboration between local level officials and court officials. Calendars heightened social distinctions and differences through their physical manifestations of different and hierarchy. Certain festivals and events also created larger goals that connected communities and allowed for the practice of a shared identity beyond a single group.[206]

Calendars regulated ceremonies carried out only by the emperor, thereby reinforcing his unique status and position. Emperors were the primary figures permitted to make sacrifices to Heaven and Earth.[207] The sacrifice to Heaven and Earth was an ancient ceremony that embodied and materialized traditional cosmology.[208] It was a dual sacrifice that connected space and time: the Square Pool in the north and the Rounded Mound in the south. These buildings were physical manifestations of the round heaven and square earth theory from the classics. Moreover, the buildings contained additional symbols and numerological relationships that illustrated the significance of the emperor and the Mandate of Heaven. The two ceremonies were performed at pivotal moments in the solar year. The ceremony was meant to mark the transition of yin and yang forces. The sacrifice for Heaven was performed on the winter solstice, at the height of yin. The sacrifice to Earth was performed on the summer solstice, at the height of yang.[209]

The state calendar informed the bureaucracy of these events and enabled local officials to prepare in advance of these events. The emperor had to prepare and purify his body to conduct this ritual. On the day before the ceremony, the emperor left the palace and went to a temporary residence. This period of transition was performed with solemnity. During this time, the emperor abstained from food and bathed. On the day of the solstice, he rose shortly before sunrise and proceeded to enter the respective temple. The procession included music and multiple attendants.

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[206] Compare Eviatar Zerubavel, *Hidden Rhythms: Schedules and Calendars in Social Life* (University of California Press, 1985), 70-100.; Kevin Birth, *Objects of Time: How Things Shape Temporality* (Palgrave Macmillan, 2012), 71-98.

[207] There were exceptions in certain circumstances such as illness or if the emperor was too young.

[208] Pietro Corradini, "The Worship of Heaven and Earth during the Qing Dynasty," *Ming Qing Yanjiu* 12, no. 1 (2003): 17–70.

[209] Angela Zito, *Of Body and Brush: Grand Sacrifice as Text/Performance in Eighteenth-Century China* (University of Chicago Press, 1997), 125-127.

The emperor burnt the offerings in the center of the building, bowed before the altars, and then exited the building.[210] Although the emperor was supposed to conduct this ceremony, the event was still a public affair because it was publicized through multiple sources.[211] The calendars contained this information, and public announcements were also made on the emperor's absence and the timing of the ceremony. Foreign visitors, who happened to witness the ceremony, claimed it was particularly impactful. "The whole scene is very impressive," wrote Henry Blodget.[212]

State calendars were references for ritual preparation beyond the inner court too. While the emperor conducted rituals on behalf of the entire empire, local magistrates carried out public ceremonies for the people under their administrative authority. These events were organized according to the first and fifteenth days of the lunar months, which meant that they were aligned with new and full moons. On these days, they sacrificed at the local temple of Confucius, and they also brought sacrifices to the City God, God of War, and God of Literature.[213]

As a scheduling device, calendars allowed for certain rituals to be conducted simultaneously across the entire empire. One such example described above was the ceremony for granting the seasons. But there were others as well. For instance, on the day called *lichun* 立春 or "establishing spring", both imperial officials and local magistrates prepared effigies of the Ox-herder Mangshen 芒神 and the Spring Ox Chunniu 春牛 according to the regulations outlined in the imperial standards. Those standards prescribed how the colors used on the effigies showcased predictions for the upcoming year's weather and harvest. During the ritual, local magistrates paraded the effigies through the city in a procession. As a part of the ceremony, they whipped the ox as a symbol of the beginning of the season's labor. In a similar manner, the first day of the planting season was also led by the government. Both emperors and local officials were involved

[210] Andrew Patton Happer, *A Visit to Peking: With Some Notice of the Imperial Worship at the Altars of Heaven, Earth, Sun, Moon, and the Gods of the Grain and the Land* (American Presbyterian Mission Press, 1879), 12-13.; Henry Blodget, "The Worship of Heaven and Earth by the Emperor of China," *Journal of the American Oriental Society* 20 (1899): 58–69.
[211] For example, see North China Herald, *Translations of the Peking Gazette* (North-China Herald and Supreme Court and Consular Gazette, 1872), 108.
[212] Henry Blodget, "The Worship of Heaven and Earth by the Emperor of China," *Journal of the American Oriental Society* 20 (1899): 66
[213] T'ung-tsu [Tongzu] Ch'ü [Qu], *Local Government in China Under the Ch'ing* (Harvard University Asia Center, 1962), 164-165.

in a ceremony with "digging" as a way to promote agriculture and symbolize the start of the year's spring planting.[214]

Although the calendar created shared schedules for organizing these events, this public infrastructure was a part of local ecology. Witnesses to the whipping of the ox ceremonies pointed out that the ceremony was widely practiced throughout the entire empire; yet local conditions shaped how magistrates practiced it. There were different types of materials used in creating the effigies. Some places used paper while others used clay and mud.[215] In Beijing, the magistrate whipped the ox throughout the streets. In other cities the effigies were mostly carried and brought to public spaces for the whipping.[216] According to one account, common folk collected paper pieces of the ox which was said to be a good luck charm for one's own oxen.[217] For Hong Kong and Guangzhou, John Gray claimed that the collecting of pieces was something that happened after the procession. On the following day, the magistrate burned the effigy of the ox in the courtyard. As the pieces of burning paper floated in the air, people fought over collecting these pieces as good luck charms.[218]

If the calendar served as an interface with the government, local conditions therefore empowered various actors to renegotiate their status through these events and public displays. In Fujian and Guangdong provinces, where local lineages played important managerial roles, gentry leaders became important participants in these state rituals. They joined the procession supporting the magistrate and military officials.[219] In other places with higher commercialization, positions could reflect economic status. For instance, William Milne was in Shanghai in 1853 and witnessed a grand affair. The ceremony included boats and theater performances in addition to the effigies and the state procession. The organizers also used the event to highlight how local merchants and

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[214] Kungang, *Qin Ding Da Qing Hui Dian (Guangxu) 欽定大清會典 光緒* (Shang wu yin shu guan, 1908), j. 27, 2b-3b.; Richard J. Smith, *Fortune-Tellers and Philosophers: Divination in Traditional Chinese Society* (Westview Press, 1991), 85.

[215] William Charles Milne, *Life in China* (G. Routledge and Co., 1857), 140-141.; John Henry Gray, *China: A History of the Laws, Manners and Customs of the People*, vol. 2 (Macmillan and Company, 1878), 115-116.

[216] Lichen Dun, *Annual Customs and Festivals in Peking as Recorded in the Yen-Ching Sui-Shih-Chi*, trans. Derk Bodde (H. Vetch, 1936), 4-6.; William Charles Milne, *Life in China* (G. Routledge and Co., 1857), 140-142; John Henry Gray, *China: A History of the Laws, Manners and Customs of the People*, vol. 2 (Macmillan and Company, 1878), 115-116.; Justus Doolittle, *Social Life of the Chinese: With Some Account of Their Religious, Governmental, Educational and Business Customs and Opinions*, vol. 2 (Harper & Bros, 1865), 19-23.

[217] William Charles Milne, *Life in China* (G. Routledge and Co., 1857), 141

[218] William Charles Milne, *Life in China* (G. Routledge and Co., 1857), 140-142; John Henry Gray, *China: A History of the Laws, Manners and Customs of the People*, vol. 2 (Macmillan and Company, 1878), 116

[219] Justus Doolittle, *Social Life of the Chinese: With Some Account of Their Religious, Governmental, Educational and Business Customs and Opinions*, vol. 2 (Harper & Bros, 1865), 19-23.

artisans had made the celebration possible. Examination candidates were involved in the entourage, and there were wooden placards displayed in the parade upon which various merchants and artisans had their names depicted along with the amount of money they had contributed to paying for the event.[220]

Ritual scheduling was not entirely public. Calendar scheduling intermingled with private and domestic rituals too. Many important family events centered on private vagaries, such as birth, marriage, and death. Yet ancestral rituals occurred during seasonal transitions.[221] Just as the emperor performed certain rites on solstices, Confucian families conducted ritual ceremonies to honor the founding ancestors of a particular lineage. Moreover, multiple points throughout the year required separate rites dedicated to specific ancestors associated with a different level of generation, such as father, grandfather, and great-grandfather.[222] Although *in practice* families drew from multiple sources regarding what kind of ritual they performed and how strictly they defined the celebrations of ancestors throughout the year, the key element of seasonal transition remained an important index marking when to conduct a ceremony.[223] It standardized the source of knowledge in practicing whatever rite. These visions too were culturally defined, as they often connected with the twenty-four seasonal qi rather than being only linked to astronomical concepts such as the solstices or the equinoxes.

The private nature of calendar consultation also fit within the ongoing demand to predict the future and support decision-making. Since each calendar contained descriptions of auspicious events and lists of stems and branches for every day, individuals used this information to plan for their own activities and adjust their efforts if needed to create the most auspicious possibilities.[224]

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[220] William Charles Milne, *Life in China* (G. Routledge and Co., 1857), 142

[221] For examples, see Hsi Chu, *Chu Hsi's Family Rituals: A Twelfth-Century Chinese Manual for the Performance of Cappings, Weddings, Funerals, and Ancestral Rites*, trans. Patricia Buckley Ebrey (Princeton University Press, 1991).

[222] Chu, *Chu Hsi's Family Rituals*., 155, 167, 170

[223] Chu, *Chu Hsi's Family Rituals*. xxix. For additional analysis on the role of these rituals, see Watson and Rawski, *Death Ritual in Late Imperial and Modern China*; Patricia Buckley Ebrey, *Confucianism and Family Rituals in Imperial China: A Social History of Writing about Rites* (Princeton University Press, 1991).; Patricia Buckley Ebrey, "The Liturgies for Sacrifices to the Ancestors in Successive Versions of the Family Rituals," in *Ritual and Scripture in Chinese Popular Religion: Five Studies*, ed. David Johnson (Chinese Popular Culture Project, 1995).; Limin Bai, *Shaping the Ideal Child: Children and Their Primers in Late Imperial China* (The Chinese University Press, 2005).

[224] Richard J. Smith, *Fortune-Tellers and Philosophers: Divination in Traditional Chinese Society* (Westview Press, 1991), 89-91.

There are numerous accounts of this type of influence on social life.[225] It impacted major life events, including marriage and burial. But it also shaped more commonplace activities. Merchants and officials consulted calendars for when to embark on their travels.[226] Different groups used calendars to determine the right day for building and construction.[227] Some even highlighted appropriate days for bathing.[228]

Although individuals purchased calendars and studied this information on their own, most individuals also relied on the market for interpretations. State calendars made time information explicit, but this was not enough to help individuals make decisions. In some cases, people had to do activities that were considered inauspicious or harmful. Therefore, various experts existed who could be consulted for advice in interpreting calendar information.[229] There were many forms of these experts. The government kept track of them through the standardization of curriculum about practices related to day selection as well as through the licensing procedures of the *yinyang* officials.[230] These calendar experts added another layer of social and material infrastructure. They charged fees for their services, and they circulated across almost all levels of society. They were universally present in daily life. Even when officials spoke against certain forms of practices that they considered superstitious, individuals continued to consult these figures as they were legitimized in traditional ritual and everyday life.[231]

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[225] Louis J. Gallagher, *China in the Sixteenth Century: The Journals of Matthew Ricci: 1583–1610* (Random House, 1953), 82-83.; George Tradescant Lay, *The Chinese as They Are: Their Moral, Social, and Literary Character. A New Analysis of the Language; with Succinct Views of Their Principal Arts and Sciences* (W. Ball and Co., 1841). Chapter 22; Justus Doolittle, *Social Life of the Chinese: With Some Account of Their Religious, Governmental, Educational and Business Customs and Opinions*, vol. 2 (Harper & Bros, 1865), Chapter 14.; Smith, "'Knowing Fate': Divination in Late Imperial China."

[226] Wu Zhongfu, *Shang Jia Bian Lan 商賈便覽* (Nanjing chu ban she, 2019), 32-35.; Richard J. Lufrano, *Honorable Merchants: Commerce and Self-Cultivation in Late Imperial China* (University of Hawai'i Press, 1997), 160.; Wu Huifang, *Wan Bao Quan Shu: Ming Qing Shi Qi de Min Jian Sheng Huo Shi Lu 萬寶全書: 明清時期的民間生活實錄* (Guo li zheng zhi da xue li shi xue xi, 2001), 298-303.

[227] Klaas Ruitenbeek, *Carpentry and Building in Late Imperial China: A Study of the Fifteenth-Century Carpenter's Manual Lu Ban Jing* (Brill, 1993), 99-106.; Wu Huifang, *Wan Bao Quan Shu: Ming Qing Shi Qi de Min Jian Sheng Huo Shi Lu 萬寶全書: 明清時期的民間生活實錄* (Guo li zheng zhi da xue li shi xue xi, 2001), 294

[228] Qintianjian, *Da Qing Jiaqing Er Shi Wu Nian Sui Ci Geng Chen Shi Xian Shu 大清嘉慶二十五年歲次庚辰時憲書*, Microfilm (National Central Library, 1819)., annotation on JQ 25.1.7, JQ 25.9.12

[229] Richard J. Smith, *Fortune-Tellers and Philosophers: Divination in Traditional Chinese Society* (Westview Press, 1991), 83

[230] Vincent Goossaert, "A Question of Control: Licensing Local Ritual Specialists in Jiangnan, 1850-1950," in *Xin Yang, Shi Jian Yu Wen Hua Diao Shi 信仰、實踐與文化調適*, ed. Paul R. Katz and Shu-fen Liu (Zhong yang yan jiu yuan, 2013).; Tristan G. Brown, "Bureaucracy from the Bottom Up: Diviners in Qing Local Governance," *Journal of Chinese History* 9, no. 2 (2025): 345–78.

[231] Richard J. Smith, *Fortune-Tellers and Philosophers: Divination in Traditional Chinese Society* (Westview Press, 1991), 90

Such consultation can be traced through the material practices of reading. Users highlighted important days in their calendars. While the state recommended annotating fast days for emperors and empresses, extant calendars show that users annotated calendars for personal reasons. They did so in several ways. Some users added black strokes against characters to draw attention to the particular activity. Other markings were more systematic. For instance, some calendars stamped red seals to mark each of the seasonal joints throughout the year.[232] The auspicious image of double happiness could be used as a seal to mark special days.[233] Another popular set of highlights was the use of circles. It looked much like the scholar practice of using circles to highlight phrases and passages in a text. In calendars, this type of highlight emphasized a particular day activity when the activities were crowded together.[234]

These marks show that users did not merely receive state time passively. They interacted with calendars as material objects, adapting official temporal information to ritual obligations, household needs, and personal decisions. This focus on knowing the right time and the proper means to recognize it contributes to an emphasis on creating more precise interpretations for what ritual to do and when to do it. I define this more in Chapter 3 as "ritual precision."

Ritual Artifact

The ritual dimensions of calendars came to include the materiality of calendars themselves. Calendars provided information about proper timing. But they were also sealed documents associated the government and the emperor. As a result, many folk were also treated as a tool or instrument for ritual itself. In certain contexts, calendars could become devotional artifacts with ritual functions of their own.

One of the most common examples of treating printed calendars as a ritual artifact was the annual removal of the Kitchen God image. As a part of folk religion, during the last month of the year, the Kitchen God left the hearth and gave his annual report to the Jade Emperor.[235] While

[232] Qintianjian, *Da Qing Xianfeng Qi Nian Shi Xian Shu* 大清咸豐七年時憲書 (1857), 15298.a.6 (20), British Library.
[233] Qintianjian, *Da Qing Tongzhi San Nian Sui Ci Jia Zi Shi Xian Shu* 大清同治三年歲次甲子時憲書 (National Central Library, 1864).
[234] For circle annotations as a reading strategy, see Li Yu, "A History of Reading in Late Imperial China, 1000-1800" (Phd Dissertation, The Ohio State University, 2003), 68-75.; Yinzong Wei, *Scholars and Their Marginalia in Late Imperial China* (Brill, 2022), 26-37.
[235] Robert L. Chard, "Rituals and Scripture of the Stove Cult," in *Ritual and Scripture in Chinese Popular Religion: Five Studies*, ed. David Johnson (Chinese Popular Culture Project, 1995), 12-20.

there were regional variations on the dates of this event, it typically occurred in the last few days of the lunar year. This popular festival can be attested well into the past. And it was associated with the printed image of the Kitchen God. The Kitchen God was typically illustrated with a pasted image placed near the hearth in the home. During the period of his absence around the New Year, the family removed the old image and burned it. Over the next few days, as the god returned to the home, the family pasted new images on the wall to represent his return.[236] This practice of burning the image and interacting with spiritual forces was intimately connected to the materiality of calendars. The illustrations of the Kitchen God contained small versions of the calendar. While the models of the Kitchen God did not all have calendars in them, extant examples make it clear that calendars were an important component of many of these illustrations.[237]

The government also treated calendars with reverence. During the presentation ceremony, calendars were placed on tables next to candles with incense. When they were handed out to individuals, the calendars were attributed to being gifts of the emperor.[238] This sacredness of the object may have also impacted local practices of burning calendars.[239] They treated calendars in the special categories of materials with writing, much like the other forms of ephemera that were collected and burned in reverence of writing.[240]

In South China, some families also incorporated calendars within the ritual setup for ancestral rites. Different seasons required different ritual objects. According to Doolittle, during the New Year, gentry families purchased calendars and placed them on the tables used in the

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[236] Robert L. Chard, "Rituals and Scripture of the Stove Cult," in *Ritual and Scripture in Chinese Popular Religion: Five Studies*, ed. David Johnson (Chinese Popular Culture Project, 1995), 17-18.

[237] Sung-lien Po and David Johnson, *Domesticated Deities and Auspicious Emblems: The Iconography of Everyday Life in Village China* (Chinese Popular Culture Project, 1992), 23-59.; Ellen Johnston Laing, *Divine Rule and Earthly Bliss: Popular Chinese Prints: The Collection of Gerd and Lottie Wallenstein* (Museum für Asiatische Kunst, 2010), 176-185.

[238] *Qin Ding Da Qing Hui Dian (Qianlong) 欽定大清會典* (Wu ying dian, 1764), j. 27, 2a; John Henry Gray, *China: A History of the Laws, Manners and Customs of the People*, vol. 2 (Macmillan and Company, 1878), 16.

[239] Alvin Pierson Parker, "The Chinese Almanac," *The Chinese Recorder and Missionary Journal*, 1888, 65.

[240] For studies on this practice, see Joseph P. McDermott, "Sacred Books and Sacred Trash," in *The Art of the Book in China: Colloquies on Art and Archaeology in Asia, No. 23, Held June 13th - 15th, 2005*, ed. Ming Wilson and Stacey Pierson (School of Oriental and African Studies, University of London, 2006).; Alexander Des Forges, "Burning with Reverence: The Economics and Aesthetics of Words in Qing (1644-1911) China," *Publications of the Modern Language Association of America* 121, no. 1 (2006): 139–55.; Adam Yuet Chau, "Script Fundamentalism: The Practice of Cherishing Written Characters (Lettered Paper 惜字紙) in the Age of Literati Decline and Commercial Revolution," in *Zhongguo Min Jian Zong Jiao, Min Jian Xin Yang Yan Jiu Zhi Zhong Ou Shi Jiao 中國民間宗教、民間信仰研究之中歐視角 Chinese and European Perspectives on the Study of Chinese Popular Religions*, ed. Philip Clart (Konfuzius-Institute Leipzig, 2012).

ancestral rites. Calendars belonged to one object among a set of New Year ritual artifacts: joss paper, rice bowls, and flower arrangements.[241]

Calendars could also be treated as sacred artifacts in healing contexts. Although special religious calendars, such as Jade Calendars, tracked the birthdays of deities, some observers noted that state calendars could also acquire sacred power because of their association with the emperor. This association granted special power to the calendar itself. Some people placed the calendar above the bed of a sick person, believing that it could help heal the patient.[242]

Memory, Storage, Recording

In addition to functioning as organizers and ritual artifacts, calendars served as writing surfaces. Although they contained printed state information, users treated them like manuscript notebooks: they wrote notes, drafted poems, recorded transactions, calculated auspicious days, tracked weather, and marked social engagements. Calendars became hybrid print-manuscript objects.

Many users engaged with their calendars as a ready source of journaling and storing information. For instance, according to one story, there was a painter named Zhu Huafeng 祝華封 from Liuli chang in Beijing who acquired a copy of a state calendar dated to the 12th year of the Kangxi emperor. The calendar was filled with calligraphy of different sizes. Some of the pages were even covered with writing on the opposite side of the page. The reason he purchased the calendar was because the handwriting contained poems. Sometime later, the collector happened to view another book, and he then discovered many of the same poems from the handwritten notes. He figured out that the calendar he had purchased contained the first draft copies of the poems by Fan Chengmo 范承謨 (1624-1676), who had served as the governor of Fujian province. The year of the calendar corresponded to the year when Fan had been imprisoned. In other words, Fan had used his official calendar as his source of paper to record his experience and personal reflections.[243]

A calendar from Tongzhi 4 (1865) attests to a similar practice of drafting poetry. The calendar contains a set of poems written on the back side of the first few pages (see Figure 1-14). The edge of the page has been cut so that the writer could use the verso side of the printed page as

[241] Justus Doolittle, *Social Life of the Chinese: With Some Account of Their Religious, Governmental, Educational and Business Customs and Opinions*, vol. 2 (Harper & Bros, 1865), 86.
[242] Henri Doré, *Researches into Chinese Superstitions*, vol. 5, trans. M. Kennelly (T'usewei Printing Press, 1918), 501-502.
[243] Xu Ke, *Qing Bai Lei Chao 清稗類鈔* (Zhonghua shu ju, 2010), jianshang 鑒賞 2, 4314.

a blank space for composing. The writer then composed drafts of three different poems on the page. The poems are titled: “Mid-Autumn” 中秋, “Mid-Autumn 2” 又, “In praise of Hakka Architecture” 咏家圍 [?]. In the poems, the author scratched out some of the first lines. He added separate characters next to certain parts of the poem, illustrating his thinking as he edited the poems. These were poems in process rather than published or transcribed poems.[244]

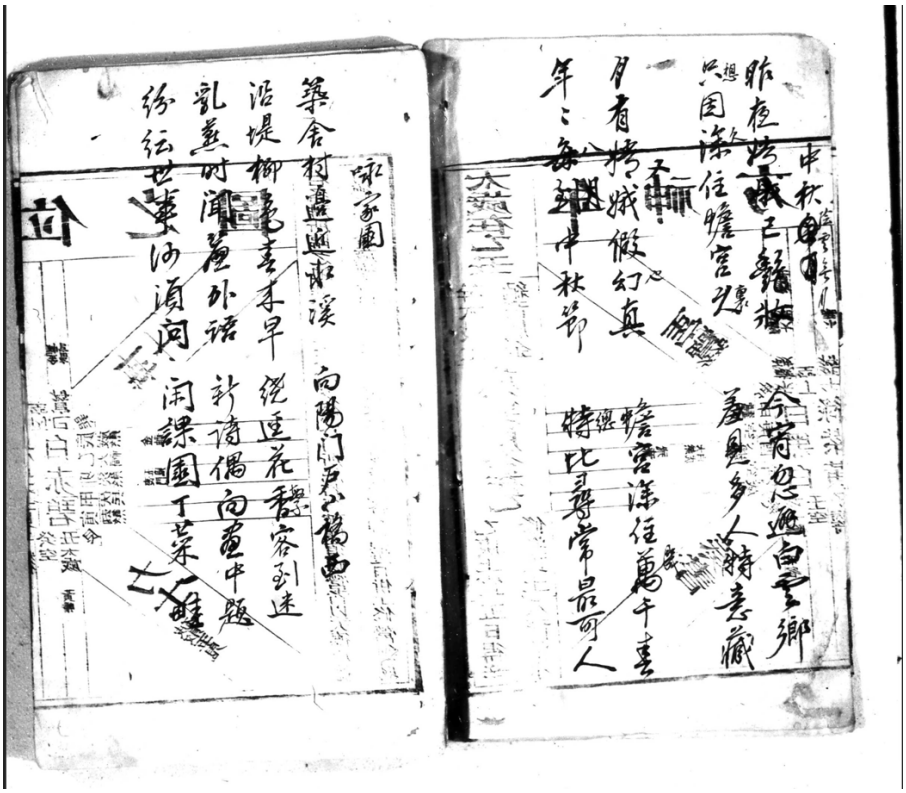

Figure 1-14 Poem marginalia. Here is a set of three poems written on the back side of the calendar pages for the annual spirits. Source: National Central Library, Da Qing Tongzhi Si Nian Sui Ci Yi Chou Shi Xian Shu, Microfilm.

Handwritten notes left on calendars reveal other forms of recordkeeping. The back page of one of the pocket calendars from the British Library contains a page replete with writing (see Figure 1-15). The notes are written in a cursive script and include references to different associations or *hui* 會. Beneath these titles, the writer added numbers (e.g. 12, 13, 14). Although the text provides little additional context for how to interpret the numbers and lists, these might be

[244] Qintianjian, *Da Qing Tongzhi Si Nian Sui Ci Yi Chou Shi Xian Shu* *大清同治四年歲次乙丑時憲書*, Microfilm (National Central Library, 1865).

donations to public charities and religious societies. One reference, for instance, is listed as being the 文昌正誕, the birthday of the Wenchang deity.[245] These were activities linked with days, but the calendar helped provide a simple canvas for recording one's transactions.

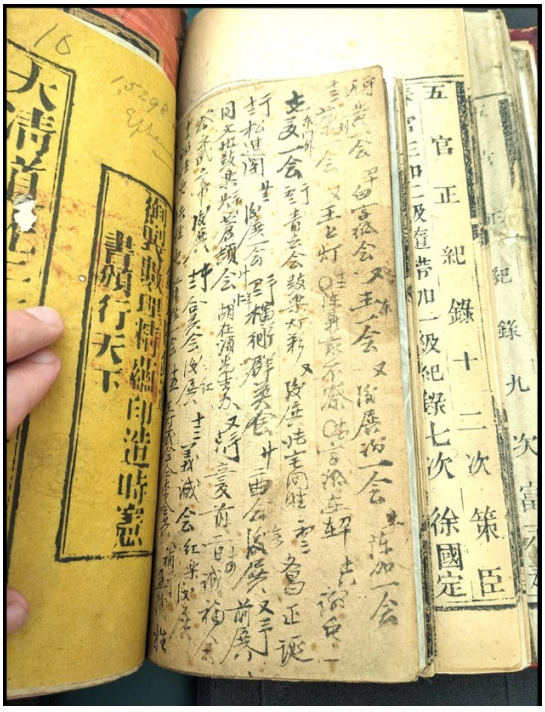

Figure 1-15 Back page of calendar annotations. These handwritten notes are on the back page of a calendar from Daoguang 21. The notes reference different local associations and provide different sets of numbers that may point to charity or other types of donations. Source: Author image, BL 15298.a.6 (9)

Another example dates to Daoguang 29 (1849). This calendar from the microfilm collection of calendars in the National Palace Museum contains multiple pages of notes related to auspicious day selection (see Figure 1-16). The calendar user turned to every blank page in the calendar, and they wrote multiple lists of day selections, associated day numbers, and different notes on those combinations. The marginalia record brief notes about connections to individual months as well as numerical calculations that corresponded to different stem and branch combinations. The writer scratched out some passages, added lines for resorting phrases, and used the space as a place for drafting ideas related to these combinations. While stem and branch terms

[245] Qintianjian, *Da Qing Daoguang Er Shi Yi Nian Shi Xian Shu* 大清道光二十一年時憲書 (1841), 15298.a.6 (9), British Library.

were obviously related to calendars, the notes provide a glimpse into the practice of using the blank pages as a site for thinking and organizing ideas.[246]

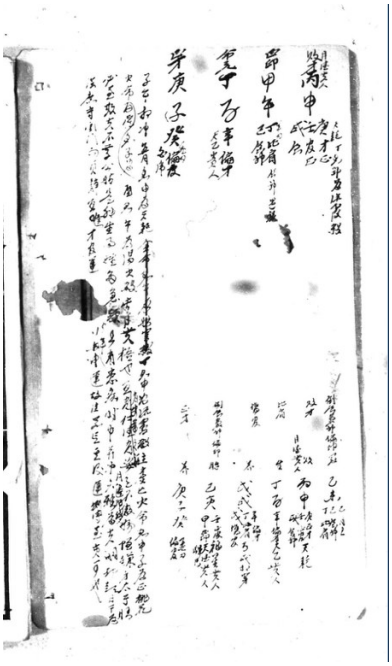

Figure 1-16 Annotations and marginalia from Daoguang 29 calendar. This set of annotations lists stem and branch combinations along with a comment on the use of combinations. This is the front blank page of the calendar filled in with the various notes. Source: Qintianjian, Daoguang 25, Microfilm (National Central Library, 1849)

Another calendar user went even further. He too used blank pages as a place to draft calculations on auspicious days. But he wrote his notes in combination with the *Sanyuan jiazi*. In the blank spaces at the beginning of his calendar, he identified which year was a *jiazi* year to start the cycle and in which cycle of the Triple Origin (i.e. *sanyuan* 三元) the *jiazi* fell. Then, he added calculations about the length of an emperor's reign in addition to the year in their reign when a *jiazi* occurred. He wrote marginal notes beneath these calculations as well.[247]

In addition to serving as drafting spaces, calendars could also function as personal diaries and journals. Records and personal accounts of events had histories that went as far back as the Song dynasty. These records could be framed according to accounts of individual days. Some of

[246] Qintianjian, *Da Qing Daoguang Er Shi Jiu Nian Sui Ci Ji You Shi Xian Shu 大清道光二十九年歲次己酉時憲書* , Microfilm (National Central Library, 1849).
[247] Qintianjian, *Da Qing Tongzhi Liu Nian Sui Ci Ding Mao Shi Xian Shu 大清同治六年歲次丁卯時憲書*, Microfilm (National Central Library, 1867).

the early forms of the genre were related to documenting travel and journeys. But the genre expanded to accommodate other types of writing. Individuals might keep these records to track financial accounts or even to record reading experiences.[248] Daily records and accounts also served to support religious practices, such as the books of merit and demerit where an individual tracked karmic responses to their actions.[249] Although the audience for this genre could be the individual or the individual's immediate family, in the Qing period, diaries and journals became increasingly public as journal writers published their records both within their lifetimes as well as shortly after their passing.[250]

Diarists were also aided by new formats that organized events according by date and time. These were blank books that were sold for the purpose of recording daily events. One such blank book was used by the diarist Xie Lansheng 謝蘭生 (1769-1831). The diary was organized in blocks with fill-in-the-blank spaces for four different units of the day: morning; midday; afternoon; evening (see Figure 1-17).[251] Another type of blank-book model was used by Weng Tonghe 翁同龢 (1830-1904) the Minister of Finance. It was even more minimal in that it consisted primarily of blank pages. But in the center of the page, the book used the sexagesimal counts to record years. One could then match months or years to the respective set of stems and branches and use those references as an organizing technique to create manuscript notes and keep daily records.[252]

[248] Huan Jin, "Stitching Words to Suture Wounds: A Manuscript Diary from the Taiping-Qing Civil War (1851–64)," *Late Imperial China* 40, no. 2 (2019): 142-146.
[249] Cynthia J. Brokaw, *The Ledgers of Merit and Demerit: Social Change and Moral Order in Late Imperial China* (Princeton University Press, 1991).
[250] For additional context on diaries as sources in late imperial China, see Henrietta Harrison, *The Man Who Awakened from Dreams: One Man's Life in a North China Village, 1857-1942* (Stanford University Press, 2005).; Tobie Meyer-Fong, "Gathering in a Ruined City: Metaphor, Practice, and Recovery in Post-Taiping Yangzhou," in *Lifestyle and Entertainment in Yangzhou*, ed. Lucie B. Olivova and Vibeke Børdahl (Nordic Institute of Asian Studies, 2009).; Jenny Huangfu Day, *Qing Travelers to the Far West: Diplomacy and the Information Order in Late Imperial China* (Cambridge University Press, 2018).; Jin, "Stitching Words to Suture Wounds."; Vincent Goossaert, "Diaries as a Window on the Private Religious Lives of Late Imperial Chinese Literati: Two Nineteenth-Century Case Studies," *Quotidiana* 1, no. 1 (2025): 55–78.
[251] Xie Lansheng, *Chang Xing Xing Zhai Ri Ji 常惺惺齋日記* (Early 19th Century), 01865, National Library of China.
[252] Weng Tonghe, *Weng Wengong Gong Ri Ji 翁文恭公日記*, Xuxiu Siku Quanshu 續修四庫全書 565–571 (1904).

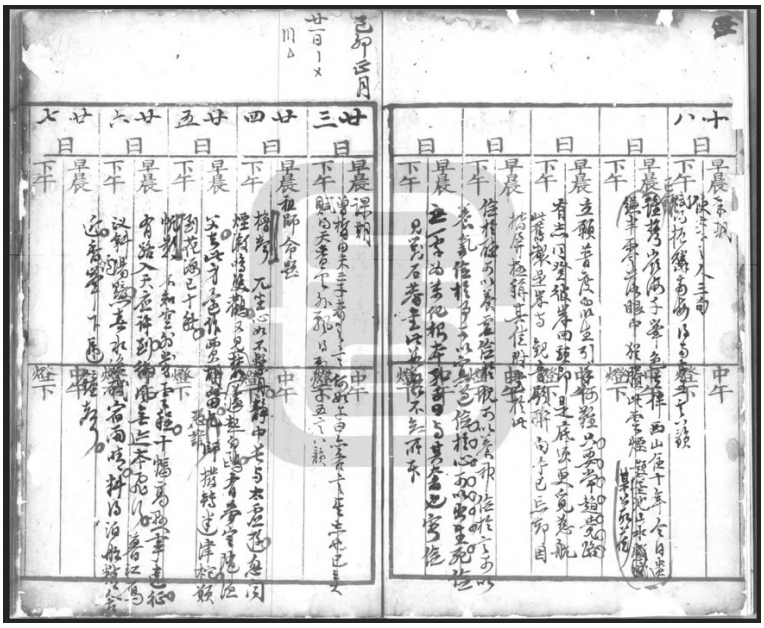

Figure 1-17 Double-page view of Xie Lansheng's diary. These pages from Xie Lansheng's diaries are organized according to the days of the month. The top of the page includes the character for day, and the user added the number. Each day column was then divided into four boxes for each day. Source: Chang Xing Xing Zhai Ri Ji, Volume 1, National Library of China

Although calendars were not blank, they offered similar structures for personal time management. For example, the owner of one calendar from Jiaqing 21 (1816) used his calendar as a private journal. He highlighted different activities throughout the year, such as days for public ceremonies or bathing. He calculated and marked the "nine-nines" in his calendar. This was a popular practice for determining when to start planting following the winter solstice. The practice was frequently practiced on paper, and there were even elaborate visualizations designed for tracking it (see Figure 1-18).[253] In this case, the calendar owner started recording the nines through his own annotations to his official calendar.

[253] Fu, "Jiu Jiu Xiao Han Tu."; Bickford, "Three Rams and Three Friends."

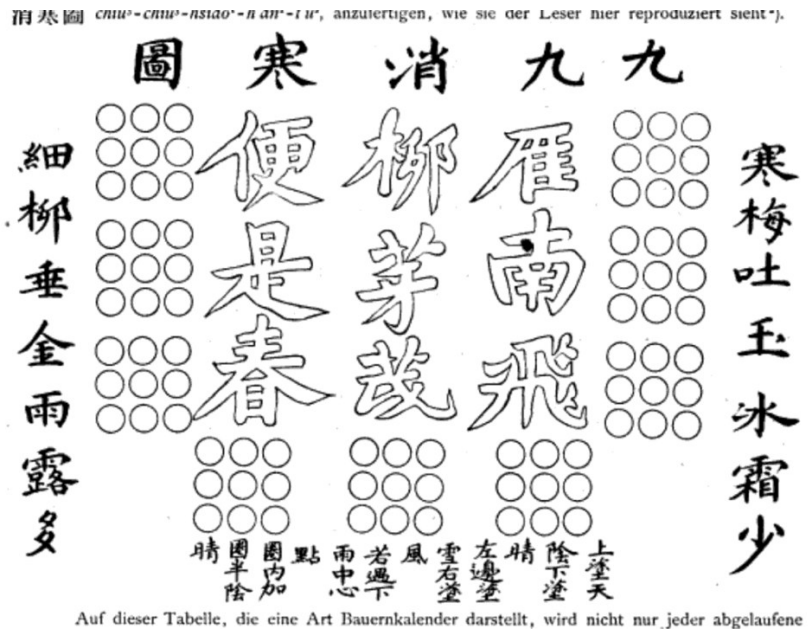

Figure 1-18 Image of the nine-nines. The illustration would be filled in to track the day as well as link to weather. Source: Wilhelm Grube, Zur Pekinger Volkskunde, 87

He also used different spaces on the calendar to keep track of his social connections. Many notes were about meetings and engagements. On the twelfth day of the ninth month, for instance, he added a reminder and record about a shared meal (i.e. 中義請吃飯 "invited to eat with Zhongyi"). On the twenty-fifth day of the tenth month, he wrote 靜異回 "Jingyi returned". On the twenty-first day of the eleventh month, he wrote 劉先生回去 "Mr. Liu has departed." The final month of the year was especially preoccupied with social engagements, eating meals with different people and visiting the homes of friends and family. He added lists of names of various people along with their names of respect or literary names (see Figure 1-19).[254]

[254] Qintianjian, *Da Qing Jiaqing Er Shi Wu Nian Sui Ci Geng Chen Shi Xian Shu* 大清嘉慶二十五年歲次庚辰時憲書, Microfilm (National Central Library, 1819)

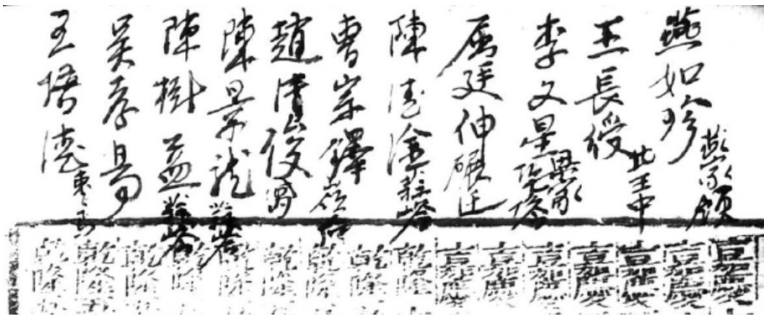

Figure 1-19 List of Names from Calendar Marginalia. These names, which I have not yet been able to identify, match some of the names mentioned in the meetings and social interactions in the calendar, pointing to the ways in which the user employed the calendar as both a planner and a repository for remembering. Source: Da Qing Jiaqing Er Shi Wu Nian Sui Ci Geng Chen Shi Xian Shu, Microfilm (National Central Library, 1819)

Calendars gave rise to a special type of recordkeeping, namely tracking the weather. Many diarists followed a formula for each day. They noted the stem and branch for the day followed by a general description of the day's weather. This type of meteorological information was also a part of daily government management, because officials had to report on weather information.[255] Consequently, official calendars were one of the places where users recorded and tracked this information.[256] Users might place it in an open space in the day column or just as frequently write the note in the top margin of the page. These notes ranged from general descriptors about the weather to the quantitative sources used in government reports. Users described one or two inches of rainfall and sometimes even greater measures for snow. One calendar user from Tongzhi 6 (1867) was especially consistent in this. He reported weather events in nearly every month of his calendar. He noted snowfall and rain reports, and he added the measurement amounts. He typically added whether the storm happened during the day or the night as well.[257]

Calendars mediated time information. They were tools for organization, and they offered a space for creative writing and inscribing. Users marked notes and highlighted ideas in calendars.

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[255] Jie Fei et al., "Dust Weather Records in Beijing during 1860–1898 AD Based on the Diary of Tonghe Weng," *Atmospheric Environment* 39, no. 21 (1994): 3943–4946; Q. S. Ge et al., "Reconstruction of Historical Climate in China: High-Resolution Precipitation Data from Qing Dynasty Records," *Bulletin of the American Meteorological Society* 86, no. 5 (2005): 671–79; Siying Chen et al., "Climate Records in Ancient Chinese Diaries and Their Application in Historical Climate Reconstruction – a Case Study of Yunshan Diary," *Climate of the Past* 16, no. 5 (2020): 1873–87.

[256] Calendars with such annotations include Qintianjian, *Da Qing Jiaqing Er Shi Wu Nian Sui Ci Geng Chen Shi Xian Shu 大清嘉慶二十五年歲次庚辰時憲書*, Microfilm (National Central Library, 1819); Qintianjian, *Da Qing Tongzhi Si Nian Sui Ci Yi Chou Shi Xian Shu 大清同治四年歲次乙丑時憲書*, Microfilm (National Central Library, 1865); Qintianjian, *Da Qing Tongzhi Liu Nian Sui Ci Ding Mao Shi Xian Shu 大清同治六年歲次丁卯時憲書*, Microfilm (National Central Library, 1867).

[257] Qintianjian, *Da Qing Tongzhi Liu Nian Sui Ci Ding Mao Shi Xian Shu*.

They could serve as reminders for events and as storage devices for tracking transactions, meetings, and social interactions. Because they were frequently consulted, they became everyday artifacts through which individuals planned activities and tracked daily experience. These inscriptions could even extend to emotional responses, as calendars provided a convenient surface for jotting down reactions and fleeting experiences.[258]

1.3 Material Frictions

Despite the state's goal of distributing calendars on time, calendars frequently arrived late. These delays created opportunities for intermediaries to fill gaps in the state's time system and develop special relationships with official calendrical authority. Such weak points can be understood as infrastructural frictions: moments when the material requirements of producing, transporting, and authorizing calendars disrupted the state's ideal schedule.[259] Coordinating calendar delivery required the mobilization of bulky packages across long distances, often through difficult terrain and under tight deadlines. Although administrative regulations presented idealized visions of distribution and management, multiple factors—i.e. spatial distance, physical geography, order size, transport technology, and human labor—determined how people experienced calendars. These frictions created gaps in the material representation of public time. Furthermore, they generated opportunities for alternative practices, as local actors provided necessary time information while adapting state infrastructure to their own needs.

Calendar delays were common in Mongolia and other northern territories (see also Appendix A:). In the Manchu provinces of the Northeast, locals wanted calendars, but they struggled to receive them on time and for them to be useful. According to the regulations, the central government maintained the responsibility for delivering calendars to this region rather than using the provincial networks and local printing services. The government tried to send Manchu materials to this region to promote the Manchu language. According to Xiqing, a government

[258] Another practice that might be added to this emotional connection is private collecting. Despite the everyday nature of calendars, some calendars merited special treatment and collecting. For example, the family of Ji Yun collected three rare calendars: the private calendars made from the Qianlong emperor after he abdicated the throne for his son. These calendars continued to use his regnal name (Qianlong 61, 62, 63), and they were privately built only for the emperor. These calendars were considered highly precious collector's items. In the opposite direction, some calendars were considered collectors items because they were ancient, such as purchasing Song dynasty calendars. Wu Yan, *Qing Dai Li Shu Yan Jiu 清代曆書研究* (Lan mu lan wen hua chu ban she, 2015). 25-28

[259] Paul Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (MIT Press, 2013), 109.

official who wrote an unofficial gazetteer of Heilongjiang Province, the central government often struggled to make deliveries by the twelfth month. Manchu-language calendars usually arrived in the first two months of the new year, even later than Mongolian-language calendars. As a result, the Chinese merchants who were involved in the tribute trade sold Chinese-language calendars as a substitute. These merchants operated on behalf of the government but maintained their own supply logistics. Locals then, who were supposed to rely on Manchu-language calendars to preserve the language, used Chinese-language calendars for organizing time, because they arrived earlier. Nevertheless, locals, in his view, still honored the Manchu-language calendars when they acquired it.[260]

It is not surprising that these deliveries were so late to frontier sites like Mongolia and Manchuria. They were far from Beijing, and because these objects were only delivered after the first day of the tenth month, the calendars were transported at the height of winter. Moreover, economic historians have pointed out that overland transportation was also costly. The Chinese heartland could rely on water transportation and river networks, but frontier sites and inland areas incurred significant costs. According to one measure, overland transportation contributed to nearly a 3 percent increase in the price of grain for every mile of overland transportation.[261] Consequently, bringing materials to remote locations like Mongolia and Manchuria had significant trade-offs.

Chinese merchants could reach the market before the government because their trade schedules differed from official calendar distribution. The sale of Chinese-language calendars was entangled within a part of the larger schedule for northern tribute trade. Starting from the fifth and sixth lunar months, northern tribes were required to appear at state depots and bring their tribute. Northern tribute included furs, pearls, ginseng, and even fish.[262] From the sixth month to the

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[260] Xiqing, *Heilongjiang Wai Ji* 黑龍江外記, Airusheng (1900), j. 5, 1b, 110.

[261] Kenneth Pomeranz and Steven Topik, *The World That Trade Created: Society, Culture, and the World Economy, 1400 to the Present* (Routledge, 2018), 53.

[262] This tribute had important changes over time. For more analysis of these relations, see Van Jay Symmons, *Ch'ing Ginseng Management: Ch'ing Monopolies in Microcosm* (Center for Asian Studies, Arizona State University, 1981); David A. Bello, *Across Forest, Steppe, and Mountain: Environment, Identity, and Empire in Qing China's Borderlands* (Cambridge University Press, 2015), 63-115; Jonathan Schlesinger, *A World Trimmed with Fur: Wild Things, Pristine Places, and the Natural Fringes of Qing Rule* (Stanford University Press, 2017); David A. Bello, "Rival Empires on the Hunt for Sable and People in Seventeenth-Century Manchuria," in *Empire and Environment in the Making of Manchuria*, ed. Norman Smith (UBC Press, 2017); Loretta E. Kim, "Inclement Weather and Human Error: Regular Irregularities in the Manchurian Tribute System during the Qing Dynasty," in *Empire and Environment in the Making of Manchuria*, ed. Norman Smith (UBC Press, 2017); Loretta E. Kim, *Ethnic Chrysalis: China's Orochen People and the Legacy of Qing Borderland Administration* (Harvard University Asia Center, 2019).

twelfth month, tribes had quotas that they had to meet.[263] Chinese merchants served as agents in this trade network. Because these merchants were operating with luxury goods, like furs, they were able to recover transportation costs.[264] Furthermore, these merchants were also able to conduct additional trade in the area through selling Chinese manufactured goods. Paper products like calendars and popular prints were other items that could be sold in the north and further manage costs.[265]

Transportation technology and physical geography remained material constraints on delivery services until the twentieth century.[266] While new technologies had an impact on speed and communication, it is important to remember that by 1911 there were still less than 6,000 miles of railroad track for the entire empire. This number also only accounted for a small amount of actual mail service.[267] Large-distance bulk packages remained embedded in older forms of communication and transportation. Despite the government's goal to create unity across space, the actual technologies that allowed for this vision always limited it.

Another limiting factor was the bottleneck in the communications network for sending packages from Beijing to the provinces. The human factor in this network meant that individuals could exert significant amounts of agency to resist the state's demands. Because the state relied on human labor to carry and transport these objects, courier liaisons had a major role in ensuring that this process functioned as expected. At the same time, courier liaisons were also limited by the couriers and individuals who they had to hire to transport the artifacts. Porters involved in this service were able to negotiate their own terms for this infrastructure.[268]

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[263] Xiqing, *Heilongjiang Wai Ji 黑龍江外記*, Airusheng (1900), j. 5, 1b, 110.

[264] Jonathan Schlesinger, *A World Trimmed with Fur: Wild Things, Pristine Places, and the Natural Fringes of Qing Rule* (Stanford University Press, 2017), 57.; For additional research on northern trade, see Christopher M. Isett, *State, Peasant, and Merchant in Qing Manchuria, 1644-1862* (Stanford University Press, 2007), 239-276.; James A. Millward, *Beyond the Pass: Economy, Ethnicity, and Empire in Qing Central Asia, 1759-1864* (Stanford University Press, 1998).; George Zhijian Qiao, "The Rise of Shanxi Merchants: Empire, Institutions, and Social Change in Qing China, 1688-1850" (Phd Dissertation, Stanford University, 2017).; Yi Wang, *Transforming Inner Mongolia: Commerce, Migration, and Colonization on the Qing Frontier* (Rowan and Littlefield, 2021).

[265] John Lust, *Chinese Popular Prints* (Brill, 1996), 69.

[266] For an excellent analysis of traditional forms of transport technologies in the Southwest, see Nanny Kim, *Mountain Rivers, Mountain Roads: Transport in Southwest China, 1700-1850* (Brill, 2020).

[267] Lane J. Harris, "The Post Office and State Formation in Modern China, 1896-1949" (Phd Dissertation, University of Illinois, Urbana-Champaign, 2012), 243, n. 59.; Joan Judge, *The Politics of Common Reading: Vernacular Knowledge and Everyday Technics in China, 1894-1954* (University of Chicago Press, 2025), 114.

[268] Compare Nanny Kim, *Mountain Rivers, Mountain Roads: Transport in Southwest China, 1700-1850* (Brill, 2020), Chapter 10.; William T. Rowe, *Hankow: Conflict and Community in a Chinese City, 1796-1895* (Stanford University Press, 1989), 231-242.

Since calendar deliveries were mandated by state deadlines, investigations into late deliveries illustrate how various intermediaries could block the flow of documents. One of the most detailed examples comes from a report that involved late calendar deliveries to Vietnam in 1833. The case raised important questions about calendar delivery because it involved the Ministry of Rites and the Qing government's direct responsibility for sending calendars to Vietnam. This responsibility had become especially significant after the Qing granted new calendrical privileges to its southern neighbor in the late eighteenth century.

On the one hand, the delivery of calendars was not a new issue, but the context of this relationship had changed in the late eighteenth century. The states in Southeast Asia had received Chinese-language calendars for long periods of time, and they had even used these calendars as sources for their own astronomical offices and local management.[269] But in the late eighteenth century, the Qing became involved in the northern and southern disputes in the states of Vietnam. One of the demonstrations of that involvement was to change the status of southern kingdoms.[270] The Qianlong Emperor did not just send calendars to the south. He added Vietnam to the Qing calendar. This meant that Vietnam was raised to a status similar to Korea. From the perspective of calendar distribution, it also meant that the government took a new responsibility to submit calendars as a part of their state infrastructure. Although Korea sent emissaries to Beijing who joined the calendar distribution ceremony and who then carried the calendars back to Korea for local reproduction, the Qing decided that Vietnam would be included in the provincial and military distribution networks.[271] This policy introduced a change in private and public networks of information. While merchants in Guangzhou and Fujian had previously been the primary transporters in selling locally produced calendars to Vietnam, the distribution of calendars beyond the southern borders now became a part of the Qing state infrastructure. It would be a part of the

[269] Thatcher E. Deane, "The Chinese Imperial Astronomical Bureau: Form and Function of the Ming Dynasty 'Qintianjian' from 1365 to 1627" (Phd Dissertation, University of Washington, 1989), 325.; Yukio Ōhashi, "Astronomy in Mainland Southeast Asia," in *Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures* (Springer Science, 2016).; Vũ Lộc Phạm and Thành Lân Lê, "A Brief History of Vietnamese Astronomy and Calendars During the Reign of the Royal Dynasties," in *Exploring the History of Southeast Asian Astronomy: A Review of Current Projects and Future Prospects and Possibilities*, ed. Wayne Orchiston and Mayank N. Vahia (Springer Cham, 2021), 128-142.

[270] For the broader context of the relationship with Vietnam, see Keith W. Taylor, *A History of the Vietnamese* (Cambridge University Press, 2013), 365-445.; John E. Wills, "Functional, Not Fossilized: Qing Tribute Relations with Đại Việt (Vietnam) and Siam (Thailand), 1700-1820," *T'oung Pao* 98, no. 4/5 (2012): 439–78.; Jaymin Kim, "Asymmetry and Elastic Sovereignty in the Qing Tributary World: Criminals and Refugees in Three Borderlands, 1630s-1840s" (Phd Dissertation, Universtiy of Michigan, 2018), Chapters 4, 5.

[271] QSL QL 54.12.4, j. 1344, 4a-8a

wider state's postal networks that connected provinces and garrisons to the capital, and according to the emperor, it would increase cross-border trade.[272]

Nevertheless, in the delivery of calendars for 1833, the calendars had not yet arrived by the first month of the new year despite having been officially sent in the tenth month of the previous year. The provincial governor informed the central government that it was a serious delay although delays were common. He wrote that Guangdong and Guangxi were accustomed to the state distribution arriving late. But this year, because no calendars had arrived at all yet, they sent a lateral notification to the provincial seat in Guangdong requesting additional copies be made there. Those calendars were then sent to Guangxi province, and the local governor then shipped the newly made copies to Vietnam. But he still sent the report back to Beijing inquiring about the status of the calendars from Beijing, because he planned on sending those calendars once they arrived.[273]

The Grand Council ordered a military investigation to determine why the shipment was so late. According to the depositions, the calendars had been sent to the Beijing office of the communications liaison for Guangxi province at the exact date, on the fourth day of the tenth month. The person in charge was named Tang Zhuoling 唐卓齡. Tang testified that the customary practice was to rely on incoming couriers who could then return with the package instead of hiring a handler to carry the packages immediately. But when the messenger arrived on the twelfth day of the tenth month, the messenger refused to carry all the calendars. It was a particularly heavy load of 101 calendars. Tang claimed that he tried to notify the officials in Guangxi that the courier would not carry the package. Yet Tang never arranged for another method of delivery. He left the position on the twelfth day of the twelfth month and handed over the problems to the new communications liaison Sun Jiahuang 孫佳璜. When Sun took over the office on the twelfth, he saw the packages in the office and realized that the calendars had not been delivered. Two couriers arrived a few days later holding express permits. So, Sun asked these two to transport the calendars back to Guangxi under the express system. Those two did take it, but they had only left on the

[272] QSL QL 54.12.4, j. 1344, 4b-5a

[273] Changling, "062825," Memorial 奏, DG 13.02.04, Archive of the Grand Council 軍機處檔案, National Palace Museum.

twenty-sixth of the twelfth month.[274] Since deliveries to Guangxi by pony express were nearly 30 days, and by foot were expected to take nearly 60 days, the calendars were indeed very late.[275]

While the officials involved were punished for the late deliveries, the investigation only highlighted the precarious nature of this infrastructure. If a courier refused to carry a package, the liaisons had limited options. Furthermore, in this case, the investigation required the liaisons hand over their records. The investigation discovered that while this particular case was a severe example, it was only the latest in a consistent pattern of lateness and poor delivery channels to frontiers.[276] In the aftermath, the Ministry of Rites tried to consider its options for dealing with calendar deliveries and considering whether they might find new solutions for using emissaries who visited the capital instead of relying so much on this network.[277]

There were other challenges in other frontier sites. In the 1850s, for instance, calendars had still not arrived at Yunnan by the appointed time. The provincial governor sent an edict complaining about the government couriers to Yunnan. In order to deliver the calendars as soon as possible, he partnered with merchants based in Sichuan province and collected additional prints taken from there to be distributed to the appropriate centers.[278] But Sichuan merchants were not always the solution. For instance, although the government did not deliver calendars in Tibetan, they did maintain military garrisons in Tibet.[279] These military units frequently turned toward Sichuan merchants to collect calendars in Manchu and Chinese, but the calendars were usually late arriving in the first months of the new year. Following complaints about this in the nineteenth century, the government then switched its policy and offered to send new volumes of their astronomical textbooks to locations in Tibet, a policy that would allow for local experts to align their learning more closely with the state's calendar making practice, and they added the military

[274] Changling, "062825," Memorial 奏, DG 13.02.04, Archive of the Grand Council 軍機處檔案, National Palace Museum.
[275] John K. Fairbank and Ssu-yu Teng, "On The Transmission of Ch'ing Documents," *Harvard Journal of Asiatic Studies* 4, no. 1 (1939): 26.
[276] Changling, "062825," Memorial 奏, DG 13.02.04, Archive of the Grand Council 軍機處檔案, National Palace Museum.
[277] Changling, "062825," Memorial 奏, DG 13.02.04, Archive of the Grand Council 軍機處檔案, National Palace Museum.
[278] Cited in Wang Yuanchong, "Qing Dai Shi Xian Shu Yu Zhongguo Xian Dai Tong Yi Duo Min Zu Guo Jia de Xing Cheng 清代時憲書與中國現代統一多民族的形成," *She Hui Ke Xue*, no. 5 (2018): 198.
[279] For recent histories of Qing policies in Tibet, see Max Oidtmann, *Forging the Golden Urn: The Qing Empire and the Politics of Reincarnation in Tibet* (Columbia University Press, 2018).; Lan Wu, *Common Ground: Tibetan Buddhist Expansion and Qing China's Inner Asia* (Columbia University Press, 2022).

garrisons in Tibet within the rest of the military infrastructure.[280] In other words, the state took on the responsibility to incorporate these distant locations within its more established military communications network already rather than relying on the local network of porters.

But these types of debates about deliveries and partnerships were not limited to frontier sites. Even places with large populations and more integrated forms of transportation and communication infrastructure experienced fragmentary outcomes of deliveries about time information. For instance, there were not enough calendars printed in Songjiang prefecture in Jiangsu province, and the local government often struggled to have enough calendars ready.[281] The local government frequently had to send requests to other provinces to collect state calendars and have them transported there.[282] Much like grain shipments, calendars were treated as resources that had to be mobilized from areas of surplus to deficits. These types of arrangements had to also be tracked with other financial reports.[283] These examples show that even though calendars were symbolically related to political legitimacy, the material frictions of temporal infrastructure created equal opportunities for creative adaptation. Calendar deliveries could easily empower intermediaries just as they represented state power.

1.4 Conclusions

In 1934 the puppet state of Manchukuo published its first state calendar: the origin year for the Kangde 康德 reign.[284] Although the Republic of China had adopted the Gregorian Calendar as the

[280] Shen Bao, 1887.11.28, 12; Kungang, *Qin Ding Da Qing Hui Dian (Guangxu) 欽定大清會典 光緒* (Shang wu yin shu guan, 1908), j. 1104, 4a.

[281] Shen Bao, 1887.2.3, 9; Shen Bao, 1887.11.7, 12; Shen Bao 1891.11.22, 9 ; Shen Bao 1893.1.12, 2; Shen Bao 1894.11.26, 9; Shen Bao 1896.1.4, 9; Shen Bao 1896.11.27, 9; Shen Bao 1899.11.14, 9; Shen Bao 1899.12.2, 10

[282] Shen Bao, 1887.2.3, 9; Shen Bao, 1895.11.18, 9; Shen Bao, 1896.11.27, 9

[283] For example, Shen Bao, 1887.2.3, 9; Shen Bao, 1895.11.18, 9. Treasury reports were submitted three times of year: *donggu* 冬估, winter estimates; *chunbo* 春撥, spring allocations; *qiubo* 秋撥, autumn allocations. Since the autumn allocations would have already determined whether an office would have been able to produce enough calendars, administrators would have already made choices about the need to mobilize more calendars for other districts and would have allowed for the reallocations in the late autumn to winter. For more on this issue of allocation reports, see Shi Zhihong, *Central Government Silver Treasury: Revenue, Expenditure and Inventory Statistics, ca. 1667-1899* (Brill, 2016), 27-29.

[284] For studies of Manchukuo, see Louise Young, *Japan's Total Empire: Manchuria and the Culture of Wartime Imperialism* (University of California Press, 1998); Prasenjit Duara, *Sovereignty and Authenticity: Manchukuo and the East Asian Modern* (Rowan and Littlefield, 2004); Shin'ichi Yamamuro, *Manchuria Under Japanese Dominion*, trans. Joshua A. Fogel (University of Pennsylvania Press, 2006); Jianda Yuan, *Chinese Government Leaders in Manchukuo, 1931-1937: Intertwined National Ideals* (Routledge, 2023).; Murata Takashi, "Regulation of Time and Folk Customs in North China during the Sino-Japanese War," in *Living and Working in Wartime China*, ed. Brett Sheehan and Wen-hsin Yeh, trans. Brett Sheehan (University of Hawai'i Press, 2022).

common calendar since the revolution, Manchukuo published its calendar under the title *Shixian shu*. In many respects, the calendar reflected its Qing forebearers. It contained illustrations of Spring Ox and annual spirits.[285] Each section detailed different times of sunrise and sunset for various localities throughout the northern provinces. The section of months and days was also designed around the same structure of introductory material and columns on auspicious and inauspicious actions. But the calendar was also different. It was produced with lithographic technologies rather than woodblock printing; it contained images of the emperor; and it paired lunar dates with the Gregorian calendar. While the calendar remained a product of astronomical calculations, it also reflected a new context of state calendars in a twentieth-century world.[286] Its form nevertheless demonstrates how Qing conventions survived political rupture by adapting to new regimes, technologies, and even temporal standards.

Throughout this chapter, I have argued that a material history of Qing calendars reveals the co-production of state power and local authority. Calendars themselves were part of the infrastructure for making time, and they standardized temporality. The networks that supported and sustained this infrastructure were elaborate. They were based communication routes, administrative offices, military logistics, commercial partnerships, printing workshops, and a public commitment to making calendrical information widely available. These systems were centered on Beijing but stretched outward across the empire. Some followed with merchant routes and commercial circuits, whereas others were embedded in military and state logistics. These channels did not end at local government offices. They extended further as local officials collaborated with printers, booksellers, village elders, hawkers, and other intermediaries who carried calendrical information into communities and villages. Together, these channels formed one of the largest publishing infrastructures of the early modern world, an empire-wide system that sought conformity and connectivity through shared calendrical practice.

Calendars formed a material bedrock that organized everyday life. This materiality appeared in design, production, distribution, and use. The government used colors, fabrics, layouts, and even languages as materializations of social roles and functions. These material distinctions

[285] This publication of the Spring Ox as a part of the official calendar is particularly interesting from the context of official versus unofficial calendars. It raises another point that at least in the twentieth century, the notion of the calendar was so linked with this ritual that the state added this to the official publications, even though Qing period calendars did not include this in the official design.

[286] Zhong yang guan xiang tai, *Kangde Yuan Nian Shi Xian Shu 康德元年時憲書* (1934), 14.6 ニ-334, National Diet Library.

mattered. Individuals and groups distinguished themselves through access to these things. They competed, argued, and petitioned to change them when they could. Even if the distribution of the calendar could always be viewed as some form of imperial grace, the external decorations, qualities of paper, and the content represented in one's calendar displayed one's closeness and centrality to that gift. The ownership of state calendars was never just about submission and loyalty but equally about declarations of power.[287]

Despite these regulations, calendars were everyday objects that were subject to the vagaries of individuals and their communities. Calendars structured public and private life, relying on astronomical measurements and celestial motion to identify seasonal change and coordinate seasonal activates. Although community differences mattered, these definitions created a certain element of sharedness.[288] They even brought different religious groups under the aegis of the imperial standards. Various religious groups, including Christians, Muslims, Buddhists, and Jews, all followed their own festivals.[289] But the role of astronomical seasons and events created large-scale continuities that brought these groups together under the authority of the state.

Individual calendar use was also shaped by systems of planning and organization based on concepts such as stems and branches. These counting systems allowed variation and alternative interpretation. Yet their complexity did not weaken their authority. State-funded sources, official textbooks, and widely circulating reference works made this complexity legible and gave it institutional force. These systems also shaped rural life, even in communities only loosely connected to administrative officials. As various observers noted, marriage, burial, and birth connected individual life courses to rhythms authorized by the state.

Nevertheless, calendars cannot be interpreted as purely instruments of imperial power. The material frictions that appeared in calendars created gaps for innovation. As print artifacts,

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[287] This might be compared with other forms of privilege and hierarchy as tactics for building connection across difference. See David Cannadine, *Ornamentalism: How the British Saw Their Empire* (Oxford University Press, 2002).

[288] This is a feature of calendrical systems that arrange calendars and festivals around astronomical events. Kevin Birth, *Objects of Time: How Things Shape Temporality* (Palgrave Macmillan, 2012), 71-97.

[289] The calendars of other religious communities all carried notes of the seasonal changes to link their community events to state calendars. See, for instance, William Charles Milne, "Notices of Seven Months Residence in the City of Ningbo," *The Chinese Repository* 16, no. 2 (1847): 60-61.; F. Farjenel and L. Bouvat, "Calendrier Musulman Chinois," *Revue Du Monde Musulman* 4, no. 3 (1908): 548–60; Eugenio Menegon, "The 'Teachings of the Lord of Heaven' in Fujian: Between Two Worlds and Two Times," in *Time, Temporality, and Imperial Transition : East Asia from Ming to Qing*, 1st ed., ed. Lynn A. Struve, Asian Interactions and Comparisons ; 8 (University of Hawaii Press, 2005).

calendars were frequently embedded in the multiple forms of print organization that altered everyday life. At the imperial level, labor organizers and carvers exercised considerable control over how calendars appeared and how groups were able to access this information. At the local level, individual resources altered the resources used in making calendars and their physical appearance. Instead of speaking about the Qing calendar, as if it is a unified object, historians might be better suited to describe the many calendars of the Qing empire.

Besides print technologies, the distribution and movement of calendars in space led to other types of material friction and resistance. Calendar networks were ultimately human networks. They were limited by other technologies of communication and transportation. Despite the vision of calendars as bringing together all communities, the uneven distribution of calendars in time and space for any particular year resulted in the constant need to innovate and create immediate solutions for locals. This sometimes resulted in the collaboration of private groups and public printers, or the result that Chinese language resources overshadowed policies of language preservation and distinction. In practice, state infrastructure fractured and frayed under the weight of the challenge to create this type of large-scale organization.

Calendars then were one component in the wider system for communicating time. Calendars were a technology that could be selectively employed and altered for different purposes. This vision of calendars reflected the kind of interface and ecology of time. The next chapter therefore builds on this observation. Since the delivery and making of calendars constantly faced frictions and gaps, how did the government try to resolve this problem? The following chapter examines private production of calendars to understand how individuals became more involved in supplying time outside of the state system.

Chapter 2 Market for Time: Commercial Regulations and the Almanacs of South China

About ten years before the Xinhai Revolution would topple the dynasty, the Wenguang lou 文光樓 print shop made its own quiet revolution in temporality. In 1903, they started to print an almanac that adopted imported technologies for typography and rejected the honors associated with the imperial calendar. Where they were supposed to include imperial titles and regnal years (e.g. Guangxu 20), the almanac makers replaced these dates with the Gregorian calendar. The Foshan-based printer claimed that they respected imperial standards within their opening pages, but on the actual calendar at the end of the booklet, they only published the Chinese calendar months and days without any reference to the imperial years. Instead, they focused on showing the relationship between the Chinese and Western calendars.[1]

The *New Almanac* (*Xin tongshu* 新通書) was not the first calendar to provide tables that matched Western dating with Chinese calendars, but they were among the first publishers to actively disregard the imperial context of the calendar. On the one hand, this rejection reflected local politics. The book targeted Chinese nationalists throughout the region from Guangzhou, Hong Kong, and the rest of the Chinese diaspora in Southeast Asia and the Pacific. From this perspective, the almanac reflected these political changes as the authors argued for modernization associated with the Western calendar.[2] But to interpret this story as a single transition overlooks a much longer trajectory and change. Throughout the nineteenth century, almanac makers started to become more visible and accepted publishers in calendar printing, and these makers in turn sold time under the view to solve audience problems. In other words, the publication of the *Xin tongshu* marked the culmination of a century-long transition whereby commercial printers and almanac makers introduced a market for time.

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[1] Wen guang lou, *Xin Tong Shu 新通書* (Wen guang lou, 1903), CE61.C6 H78 1903, Charles E. Young Research Library, University of California Los Angeles. 8b, Gui mao nian da zi tong shu zheng yue xiao, 1a-1b.

[2] Many of Sun Yat Sen's connections were to the business community of Guangzhou. Jonathan D. Spence, *The Search for Modern China* (W. W. Norton & Company, 2013), 225-226, 244-249. For the specific case of revolutionary action in Guangdong, see Edward J. M. Rhoads, *China's Republican Revolution: The Case of Kwangtung, 1895-1913* (Harvard University Press, 1975).

Whereas chapter one discussed *state calendars*, this chapter investigates the *private market*. Private almanac makers became creative innovators who used their connections to the bureaucracy to circulate calendars. Although the state initially tried to control private printing through regulations, the central government decided to permit private printing under certain conditions. This process started in the eighteenth century, and it accelerated following the decisions involved in the 1816 case around private calendar printing. These changes fostered what I call a "market for time": a commercial field that gave individuals choices in how they defined and used time, while also depending on the commodification of calendrical tools and instruments. In the nineteenth-century, private almanac makers refined calendar organization to make it more searchable and accessible. This market for time resulted in greater fluidity as these printers targeted niche communities in the distribution and production of their almanacs and calendars.

This chapter therefore documents how material infrastructure changed as businesses competed with state calendars through the publication and circulation of related documents that we refer to as almanacs or *tongshu*. Historians have studied almanacs as a window into everyday life in late imperial China. Prior research has examined them as both sites of resistance and purveyors of state orthodoxy.[3] Chinese almanacs shared similarities with European almanacs. They were both platforms for private astrology, weather forecasting, and long-term planning; they both popularized practical information in addition to calendars, like common recipes for health and healing, news, and general tips.[4] In the case of China, almanacs occupied a precarious position from the view of censorship. They were constantly in demand yet equally feared as a threat to the state.[5]

Previous studies have focused on content, but less research has looked at almanacs from the perspective of publication, book history, and as material texts. This chapter accordingly introduces a materialist and book historical approach to almanacs. It explains how almanac makers helped create new permission around markets for time. I combine analysis of editions with state

[3] The two historians who have probably done the most to promote the use of almanacs as a source for social and cultural history are Richard Smith and Huang Yi-Long. Both Smith and Huang have argued that almanacs reinforced state orthodoxy through their use of day selection and calendaring. But they also included peculiarities that made them either local and regional or engaged in practices that were not always appreciated by Confucian elites. Richard Smith, *Chinese Almanacs* (Oxford University Press, 1992); Huang Yi-Long, "Tong Shu Zhong Guo Chuan Tong Tian Wen Yu She Hui de Jiao Rong 通書中國傳統天文與社會的交融," *Hanxue Yanjiu* 14, no. 2 (1996): 159–86.

[4] For an explicit comparative study of almanacs, see Nan Wang, "Time and Change: A Comparative Study of Chinese and Western Almanacs" (Masters Thesis, Rice University, 1992).

[5] Whitfield, "Under the Censor's Eye."; Smith, *Fortune-Tellers and Philosophers*. 87-88

archival, legal, and administrative records to recover the material practices around almanacs in design and use. Part I outlines how a market for time developed over the course of the dynasty. The Qing initially adopted strict models that viewed private calendar printing as inimical to state authority. But distribution problems with the state calendar generated debate on access and circulation. Following several landmark decisions, the Qing clarified what authority meant in the context of calendar printing and how private merchants might be able to participate in selling calendars of their own making. By the nineteenth century, these changes resulted in a relaxation on the private printing of almanacs and had unintended consequences in advancing counternarratives to the state.

Part II homes in on a case study of the commercial printers and almanac makers of South China. Because the records of South China have been particularly well-preserved, these prints offer a glimpse into almanac making as a business and knowledge practice. The prints carry historical traces for understanding the practices involved in private almanac making. These practices became increasingly defined by creative applications to make time information easily searchable for readers. If the variations in state calendars can best be attributed to the vernacular context of printing, then privately printed calendars and almanacs represent how the market for time promoted a commercial mindset, one that both maintained respect for the tradition and provided new approaches to appeal to audiences.

2.1 Commercial Regulations

The circulation of private calendars and information on compiling such calendars long troubled Chinese empires because this information could undermine the government's claims to authority. These issues resulted in a variety of regulatory approaches for managing the sale of calendars and calendrical knowledge. Before discussing the Qing in detail, I first outline several precedents that contributed to their policies.

First, the relationship between private and public calendars was not always in opposition. Some private practices around calendars and divination were tolerated during the Han 漢 (206 BCE – 220 CE) dynasty, yet certain esoteric books became the target of state censorship by the

end of the period.[6] In 268 CE, the Western Jin 西晉 (266-316 CE) published an edict banning the private ownership of books on astronomy and *chenwei* 讖緯 texts.[7] The *chenwei* texts were apocryphal books, some of which were attributed to Confucius. They contained speculative and mystical interpretations of the classics, and they were linked to prediction, astrology, and divination.[8] Subsequent rulers continued to pass similar edicts banning the private ownership of such texts.[9]

These bans acquired a new character during the Sui 隋 (581-618 CE) and Tang 唐 (618-907 CE) dynasties. Although private calendars existed prior to this period, the genre became increasingly intricate as it combined lists of days with additional information used for divination and charms used for warding off evil, healing, or other influences.[10] Rulers started to pass bans on these books and the private ownership of other tools that could be used to compile them.[11] The Tang legal code contained broad bans on the private study of astronomy and astrology.[12] One such genre included the *Qiyao* 七曜 *Seven Luminaries* almanacs. These texts were popular tables used to compile horoscopes and astrological charts. According to contemporary bibliographic lists,

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[6] Donald Harper, "Daybooks in the Context of Manuscript Culture and Popular Culture Studies," in *Books of Fate and Popular Culture in Early China: The Daybook Manuscripts of the Warring States, Qin, and Han*, ed. Donald Harper and Marc Kalinowski (Brill, 2017); Marc Kalinowski, "Hemerology and Prediction in the Daybooks: Ideas and Practices," in *Books of Fate and Popular Culture in Early China: The Daybook Manuscripts of the Warring States, Qin, and Han*, ed. Donald Harper and Marc Kalinowski (Brill, 2017); Liu Lexian, "Daybooks: A Type of Popular Hemerological Manual of the Warring States, Qin, and Han," in *Books of Fate and Popular Culture in Early China: The Daybook Manuscripts of the Warring States, Qin, and Han*, ed. Donald Harper and Marc Kalinowski (Brill, 2017).

[7] An Pingqiu and Zhang Peiheng, *Zhongguo Jin Shu Da Guan 中國禁書大觀* (Shanghai wen hua chu ban she, 1990), 15.

[8] Fung Yu-lan, *A History of Chinese Philosophy*, vol. 2, trans. Derk Bodde (Princeton University Press, 1953), 88-91.; Hans Van Ess, "The Apocryphal Texts of the Han Dynasty and the Old Text/New Text Controversy," *T'oung Pao* 85, no. 1 (1999): 29–64.; Zhang Fengyi, "The Influence of Chenwei on Han Dynasty Literature and Literary Theory," *Journal of Chinese Humanities* 8, no. 1 (2022): 58–115.

[9] An Pingqiu and Zhang Peiheng, *Zhongguo Jin Shu Da Guan 中國禁書大觀* (Shanghai wen hua chu ban she, 1990), 13-19.; Susan Whitfield, "Under the Censor's Eye: Printed Almanacs and Censorship in Ninth-Century China," *British Library Journal* 24, no. 1 (1998): 10-11.

[10] Alain Arrault, "Les Premiers Calendriers Chinois Du IIe Siècle Avant Notre Ère Au Xe Siècle," in *Les Calendriers: Leurs Enjeux Dans l'espace et Dans Le Temps : Colloque de Cerisy, Du 1er Au 8 Juillet 2000*, ed. Jacques Le Goff (Somogy, 2002), 172-177; Alain Arrault and Jean-Claude Martzloff, "Calendriers," in *Divination et Société Dans La Chine Médiévale: Étude Des Manuscrits de Dunhuang de La Bibliothèque Nationale de France et de La British Library*, ed. Marc Kalinowski (Bibliothèque nationale de France, 2003), 87.

[11] For details on banned books, see An and Zhang, *Zhongguo Jin Shu Da Guan 中國禁書大觀* (Shanghai wen hua chu ban she, 1990), 17-31.

[12] Edward H. Schafer, *Pacing the Void: T'ang Approaches to the Stars* (University of California Press, 1977), 12.; Wallace Johnson, *The T'ang Code: Volume I, General Principles* (Princeton University Press, 1979), 180.; Susan Whitfield, "Under the Censor's Eye: Printed Almanacs and Censorship in Ninth-Century China," *British Library Journal* 24, no. 1 (1998): 12

there were more than twenty books in this genre already in this period, and it continued to circulate well into the Song as well.[13]

The rise of woodblock printing exacerbated this issue, for it both accelerated the reproduction of these texts and created greater challenges in controlling their circulation. Religious institutions pioneered the first applications of printing, but the technology spread beyond this context to the reproduction of other types of texts.[14] The area around Chengdu became an important center of printing. Different reports from the late Tang period speak to its success in publishing material related to astronomy and astrology.[15] This included calendars. One such extant calendar dating to 882 CE was found among documents at Dunhuang. Originally from Chengdu, the calendar was privately printed by Fan Shang 樊賞.[16] To limit the circulation of these documents and the leaking of calendar information, the government forbade local officials from working with these printers.[17]

Because outright bans had limited effects, the Song 宋 dynasty tried to monopolize the entire printing process. The Song adopted the Tang precedents. They banned the private possession of astronomical tools and texts used in compiling almanacs. At the same time, they directed the Astronomical Bureau to collect private almanacs and calendars and then to work with printers to sell calendars for the public. They centralized the production under state management. They passed edicts that banned the private printing of calendars and tried to maintain a public service in the distribution.[18] The penalties for violation were severe. According to the laws recorded in 1202, those who pirated state calendars were subject to 100 blows of the heavy stick while those who

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[13] Susan Whitfield, "Under the Censor's Eye: Printed Almanacs and Censorship in Ninth-Century China," *British Library Journal* 24, no. 1 (1998): 13; Ho Peng Yoke, *Chinese Mathematical Astrology: Reaching Out To the Stars* (Routledge, 2003), 71-73.; Jeffrey Kotyk, "Iranian Elements in Late-Tang Buddhist Astrology," *Asia Major* 30, no. 1 (2017): 25–58; Jeffrey Kotyk, "The Chinese Buddhist Approach to Science: The Case of Astronomy and Calendars," *Journal of Dharma Studies* 3 (2020): 273–89.

[14] Tsien Tsuen-Hsuin, *Science and Civilisation in China, Part 1, Paper and Printing* (Cambridge University Press, 1985), 146-159.

[15] Tsien, *Science and Civilisation in China, Part 1, Paper and Printing* (Cambridge University Press, 1985), 151-152.; Susan Whitfield, "Under the Censor's Eye: Printed Almanacs and Censorship in Ninth-Century China," *British Library Journal* 24, no. 1 (1998): 13-14

[16] Whitfield, "Under the Censor's Eye," 15; Alain Arrault and Jean-Claude Martzloff, "Calendriers," in *Divination et Société Dans La Chine Médiévale: Étude Des Manuscrits de Dunhuang de La Bibliothèque Nationale de France et de La British Library*, ed. Marc Kalinowski (Bibliothèque nationale de France, 2003), 94.; Alain Arrault, "Les Premiers Calendriers Chinois Du IIe Siècle Avant Notre Ère Au Xe Siècle," in *Les Calendriers: Leurs Enjeux Dans l'espace et Dans Le Temps : Colloque de Cerisy, Du 1er Au 8 Juillet 2000*, ed. Jacques Le Goff (Somogy, 2002), 182.

[17] Chan Hok Lam, *Control of Publishing in China: Past and Present* (Australian National University Press, 1983), 2.

[18] Whitfield, "Under the Censor's Eye," 13-14; Chan, *Control of Publishing in China*, 4-5.

created abridged versions of the calendar were subject to 80 blows. These punishments were also related to the private ownership of instruments: those found with astronomical charts and instruments would be sentenced to exile up to 3,000 li.[19]

Although the Yuan period saw greater collaboration with print shops, the Ming period introduced even stricter punishments and controls over the private production of calendars and the rise of private almanacs. The Ming law code defined private calendar printing in the section on forging documents. Privately printed documents were treated as cases of forging a government seal. The penalty for this crime was beheading, and the state offered rewards of 50 taels of silver for those who reported on people committing these acts.[20]

Consequently, by the time of the Qing empire, the government had a variety of different solutions for how to deal with commercial regulations and private calendar printing. The question remained to what extent should the government encourage private printing to make calendar information more public and equally how should the state control this information to protect the state's legitimacy. The tension between these two choices did not always lend itself to a simple solution. Over time, different factors also came to impact the government's perception of calendar production and its relationship to merchants. In order to simplify this process, I have divided the Qing policies into three categories: 1) the early Qing 1644 to 1720; 2) mid-Qing, 1720-1800; and 3) late Qing, 1800-1912. By the late Qing, although the state continued to publish legislation and punish illegal calendar sales, the government largely accepted private markets so long as commercial merchants did not claim to reproduce the government seal. But this was never a perfect one-to-one match. Nor did it entirely resolve political tensions. The circulation of calendars continued to lead to questions of sovereignty as the problem of calendar standards remained an important motivation to the production of multiple systems of calendars.

Private Almanacs and the Early Qing, 1644 to 1720

The early Qing period marked an important transition in the consolidation of Qing power. As the Manchus centralized their control over China proper and the frontiers, Beijing gradually asserted

[19] Chan, *Control of Publishing in China*, 5.; William P. Alford, *To Steal a Book Is an Elegant Offense: Intellectual Property Law in Chinese Civilization* (Stanford University Press, 1995), 13-14.
[20] Ko Sa-Kyŏng and Kim Chi, *Da Ming Lü Zhi Jie 大明律直解* (1395; Chaoxian zong du fu zhong shu yuan, 1936), j. 24, 6a-6b, 537-538.

its authority by passing restrictions on the private production of calendars and almanacs. As discussed in the previous chapter, the government swiftly adopted a new calendar and called it the *Shixian li* 時憲曆 in 1644. Nevertheless, this calendar did not circulate widely when it was first adopted. It competed with several other contemporary calendars. For much of the seventeenth century, the Qing held a fragile alliance between different interests as several contenders challenged Qing authority. Internal conflicts among Manchu nobles contributed to these issues of centralization. However, once the Kangxi Emperor started to expand the empire following several revolts and the final defeat of the Southern Ming rulers, calendar distributions became more aligned with the imperial interests. Whereas the government had initially prioritized basic local control, now the government targeted private almanac making as a problem of political authority.

During the first years of Qing rule, the Manchus struggled to squash local calendar publication for multiple reasons. First, starting from the mid-sixteenth century onwards, calendar knowledge had already seeped beyond the court into wider everyday life. Early Ming policies had indeed taken a strict interpretation of the law. But as the eclipse and comet predictions from the calendar became less precise over time, the government actively sought new solutions for calendar systems. Individuals submitted calendar reform proposals. Some proposals were based on lineage astronomers associated with the bureau, but other proposals came from outside the court.[21] Xu Guangqi and the Jesuit reformers became one of the most influential groups.[22] Yet there were others involved as well. For instance, a local scholar from Chengdu published his own astronomical system in the 1630s. Although his system was ultimately rejected, the fact that individuals in frontier provinces like Sichuan were able to provide competitive sources of astronomical information related to the calendar system attests to the point that the state had significantly relaxed its rules on the public dissemination and training in calendar knowledge as they sought proposal to reform the calendar.[23]

Moreover, during this same period, almanacs and calendar information became staples of the commercial print industry. The late Ming publishing boom substantially increased access to

[21] Willard J. Peterson, "Calendar Reform Prior to the Arrival of Missionaries at the Ming Court," *Ming Studies*, no. 1 (1986): 45–61.; Thatcher E. Deane, "The Chinese Imperial Astronomical Bureau: Form and Function of the Ming Dynasty 'Qintianjian' from 1365 to 1627" (Phd Dissertation, University of Washington, 1989), 401-441.
[22] Hashimoto Keizo, *Hsu Kuang-Ch'i and Astronomical Reform: The Process of the Chinese Acceptance of Western Astronomy, 1629-1635* (Kansai University Press, 1988).
[23] Adam Schall von Bell, *Xue Li Xiao Bian 學歷小辯* (1631), Chinois 4951, Bibliotheque Nationale de France, Département des Manuscrits, j. 1, 25a-30b.

this knowledge. One of the most important genres of the commercial industry was encyclopedias for daily use or *riyong leishu* 日用類書. These encyclopedias compiled useful information and targeted scholars and merchants.[24] Most of these encyclopedias included sections devoted to knowing and finding the right time for daily activities. According to Lucille Chia, the commercial publishers of Fujian relied extensively on this type of literature. It made up more than 40% of their books.[25] Some commercial houses went further than just recompiling techniques. The Yu 余 family, for instance, who were one of the most successful publishers from Fujian, created their own almanac. The family reprinted the almanac multiple times over several generations, and the almanac consolidated calendar information into a single volume.[26]

Popular demand for calendar information encouraged profit-making in selling time information. Ming officials benefited under the table by using calendars as commercial products. In 1494, for instance, a student from the Astronomical Bureau submitted a memorial to the Ministry of Rites complaining that calendars were used as a profit-making mechanism by students and officials. He claimed that provincial officials who received calendars that they were supposed to reprint for their province traveled to the capital to work with merchants and sell more calendars in a "secondary" distribution. Following deliberations, the Ministry of Rites made a surprising recommendation. While in principle they agreed with the point that calendars did represent a special type of document that should not be commercialized, they recognized that every year there were shortfalls in the number of calendars available. So, they claimed that the practice was generally acceptable if it did not become an entirely profit-driven enterprise. They encouraged officials to bring calendars to the capital to support the unmet demand for calendars.[27]

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[24] Shang Wei, "The Making of the Everyday World: Jin Ping Mei Cihua and Encyclopedias for Daily Use," in *Dynastic Crisis and Cultural Innovation: From the Late Ming to the Late Qing and Beyond*, ed. David Der-Wei Wang and Shang Wei (Harvard University Asia Center, 2005); Benjamin A. Elman, "Collecting and Classifying: Ming Dynasty Compendia and Encyclopedias (Leishu)," *Extrême-Orient Extrême-Occident*, 2007, 131–57.

[25] Lucille Chia, *Printing for Profit: The Commercial Publishers of Jianyang, Fujian (11th–17th Centuries)* (Harvard University Asia Center, 2003), 312-313.

[26] Huang Yi-Long, "Tong Shu Zhong Guo Chuan Tong Tian Wen Yu She Hui de Jiao Rong 通書中國傳統天文與社會的交融," *Hanxue Yanjiu* 14, no. 2 (1996): 165; Suyoung Son, "Publisher at Work: Yu Xiangdou's Self-Images," *Harvard Journal of Asiatic Studies* 82, no. 1 (2022): 37–76.

[27] Thatcher E. Deane, "The Chinese Imperial Astronomical Bureau: Form and Function of the Ming Dynasty 'Qintianjian' from 1365 to 1627" (Phd Dissertation, University of Washington, 1989), 324.

Surviving examples from the late Ming suggest that profit likely did occur because of this practice in bringing calendars to markets. There is such a calendar that has survived from 1568.[28] The calendar is a state calendar, but not the typical daily and monthly calendars. Instead, it is one of the ephemeris calendars, which provides celestial positions of the planets that were important in almanac making, judicial astrology, and popular astrology. Today, the calendar exists in multiple collections, having been split and sold in parts upon its arrival in Europe.[29] But the calendar belongs to the world of commercial print. The title page of the calendar lists the printer as Yu Zhangde 余彰德, one of the printers from the Yu family from Fujian.[30] Even though these calendars were staples of the state calendar system, private printers collaborated with the government to print these materials.

The commercialization of calendars started in the late Ming. Therefore, when the Manchus first started distributing the state calendar, they faced a more complex situation regarding relationships with commercial printers. There were already private almanacs alongside state calendars, and there were customary practices in place that added friction to the relationship between the local government officials and commercial printers. The early Qing then tried to remind the public that private calendar printing was illegal. They adopted the Ming regulations, and they started printing the prohibitions on the front cover of the state calendars in imitation of the Ming calendars (see Figure 2-1, Figure 2-2), repeating the same information about beheading and rewards for reporting on pirated editions.

[28] Xie Chaojue, ed., *Jin Yi Si Tian Tai Jiao Zheng Xin Qin Jing Ban Qi Zheng Quan Shu 謹依司天臺校正新鋟京板七政全書* (1568), Sin 133-C, Österreichische Nationalbibliothek.
[29] *Chinesischer Kalender Aus Der Regierungszeit Des Kaisers Kiatzing von Der Ming-Dynastie (1559 - 1568)* (1568), R 16 Kal 1, Württembergische Landesbibliothek.; David Helliwell, "An Astrological Calendar," *Serica*, March 2, 2025, https://serica.blog/2025/03/02/an-astrological-calendar/.
[30] Lucille Chia, *Printing for Profit*, 89.



Figure 2-1: Frontpage of Calendar from the Kangxi Reign. The front piece contains the same warning as earlier Ming calendars with the changes to the name of the calendar. “The Imperial Astronomical Bureau memorializes and allows the calendar made with the state seal to be distributed to all the people under heaven. Forgers will be beheaded according to the law. For the one who reports and arrests such an offender, the local government will reward him with 50 liang, if there is no government seal and it is a privately printed calendar. 欽天監奏准印造時憲曆日頒行天下偽造者依律處斬有能告捕者官給賞銀五十兩如無本監曆日印信即同私曆”. Source: Qintianjian, Da Qing Kangxi San Shi Wu Nian Sui Ci Bing Zi Shi Xian Li 大清康熙三十五年歲次丙子時憲曆, Microfilm (National Central Library, 1696).

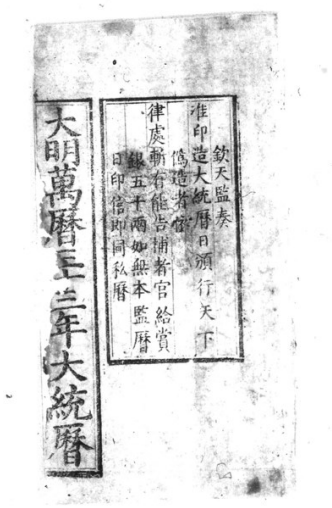

Figure 2-2: Frontpage of Calendar from the Wanli Reign. The front page contains the warning about private printing. Source: Qintianjian, Da Ming Wanli San Shi San Nian Da Tong Li 大明萬曆三十三年大統曆, Microfilm (National Central Library, 1606).

The language sounded draconian, but actual calendars attest to its limitations. One of the earliest surviving calendars from the Qing is in fact a privately produced calendar.[31] It dates to 1652, and it employs the Shunzhi reign title. It does not contain any kind of government seal showing that the printer received state permission. Nor does the calendar contain official information required in state calendars. The opening pages differ widely from official calendars. They contain a hodge-podge of texts relevant to almanacs, such as material on the Spring Ox and Cowherder, the text of the *Earth Mother Classic* 地母經, and even the healing talismans attributed to the Celestial Master Zhang.[32] Despite respecting the imperial calendar as a standard, this print obviously violates the imperial regulations as an almanac.

While the geographic origin of this Shunzhi period calendar is unclear from the pages themselves, it is entirely possible that the pamphlet comes from South China. The Qing struggled to exert calendar authority in the south for a large portion of the seventeenth century. The Qing did secure control over Nanjing in 1645 to 1646, yet Ming loyalists continued to resist the Manchus in Fuzhou, Guangzhou, and then Taiwan until the 1680s.[33] During these campaigns, the Qing relied on Chinese generals Geng Jingzhong 耿精忠 (d. 1682), Shang Zhixin 尚之信 (1636–1680), and Wu San'gui 吳三桂 (1612-1678), also known as the Three Feudatories, to help suppress these movements and administer those regions. These generals had considerable autonomy under their domains. They later rebelled against the Qing, leading to additional campaigns during the Kangxi reign.[34]

Given how chaotic this period was, local almanac makers continued to produce their own almanacs which expanded on the calendar in defiance of imperial regulations. For instance, there

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[31] Anonymous, *Shunzhi Ren Chen 順治壬辰* (1652), Chinois 4974, Bibliotheque Nationale de France, Département des Manuscrits.

[32] Xiao Dengfu, "Hou Tu Yu Di Mu: Shi Lun Tu Di Zhu Shen Ji Di Mu Xin Yang 后土與地母: 試論土地諸神及地母信仰," *Shi Jie Zong Jiao Xue Kan* 4 (2004): 1–41.; Richard Smith, "The Legacy of Daybooks in Late Imperial and Modern China," in *Books of Fate and Popular Culture in Early China: The Daybook Manuscripts of the Warring States, Qin, and Han*, ed. Donald Harper and Marc Kalinowski (Brill, 2017), 355.; Ying Zhang, "Combating Illness-Causing Demons in the Home: Fabing Treatises and Their Circulation from the Late Ming Through the Early Republican Period," *Late Imperial China* 39, no. 2 (2018): 59–108.

[33] For detailed studies of these events, see Wakeman, Jr., *The Great Enterprise*, vol. 1.; Lynn A. Struve, *The Southern Ming, 1644-62* (Yale University Press, 1984).; Tonio Andrade, *How Taiwan Became Chinese: Dutch, Spanish, and Han Colonization in the Seventeenth Century* (Columbia University Press, 2010).; Xing Hang, *Conflict and Commerce in Maritime East Asia: The Zheng Family and the Shaping of the Modern World, c. 1620-1720* (Cambridge University Press, 2015).

[34] Frederic Wakeman, Jr., *The Great Enterprise*, 1099-1105.; Kai-fu Tsao, "The Rebellion of the Three Feudatories against the Manchu Throne in China, 1673-1681: Its Setting and Significance" (Phd Dissertation, Columbia University, 1965).

is a calendar from 1671 that shares a similar practice as the earlier Shunzhi calendar. The 1671 calendar is from Guangzhou, and it calls itself an almanac "*tongshu*" rather than a state calendar to distinguish itself. The full title attributes the almanac to someone named Chen Liangjun 陳良駿 as the compiler, and it was printed by a figure surnamed Zheng 鄭 from Guangzhou.[35] At the same time, a counter set of calendars sponsored by the Zheng family circulated from Taiwan. These calendars in contrast to other Ming calendars made no claims about respecting seals and pirating. They were based on the older Ming system of calendar reckoning, yet they encouraged private printers to reproduce and circulate them. And they existed throughout Chinese diaspora communities in East Asia.[36]

After the Qing started to exert more control over this region from the 1680s, many of the almanac makers in South China continued to compete with the imperial calendar. Several extant almanacs help clarify how these authors understood their practice. First, according to the writings of almanac makers, they viewed state calendars and almanacs, while based on similar sets of information, as serving different public purposes. In the preface to an almanac from Kangxi 55 (1716), the compiler Zhang Youfeng 張友峰 wrote that calendars respected the *Shixian* calendar system, but they were not simply lists of days. He came from the region around Shanghai, and he wrote, "The Comprehensive Book (i.e. almanac, *tongshu*) establishes good and bad fortune and clarifies what to avoid and what to pursue."[37] While the imperial calendar laid out a table of days and outlined a technical system with rules, almanacs communicated the "subtleties" and "mysteries" of cosmic relationships. Zhang suggested that its authority came from understanding the interpretations of the *Book of Changes* and the flow of yin and yang. But this also had an empirical basis, because it was founded on the tables and charts of heavenly motion. The publication of almanacs went beyond just calendaring. It represented the interpretation of star-watchers (*xingxue jia* 星學家) who had specialized knowledge and experience that came from

[35] Anonymous, *Chen Liang Jun Xuan Xin Hai Nian Tong Shu Bian Lan 陳良駿選辛亥年通書便覽* (1671), Sinica 96, Bodleian Library.
[36] Zheng, *Da Ming Yongli Er Shi Wu Nian Da Tong Li 大明永曆二十五年大統曆* (1671), Sinica 58, Bodleian Library. For additional details on Southern Ming calendars, see Huang Dianquan, *Nan Ming Da Tong Li 南明大統曆* (Hai dong san fang, 1964).
[37] 夫通書者定吉凶明趨避之書也. Zhang Youfeng, *Da Qing Kangxi Wu Shi Wu Nian Sui Ci Bing Shen Bian Lan Quan Tong Shu 大清康熙五十五年歲次丙申便覽全備通書* (1716), 18765, National Library of China. Preface, 1a

their practice and transmitted books. As Zhang emphasized, this was useful knowledge for the common people, and it was not just a small addition to calendar information.[38]

Another writer in an almanac from Yongzheng 2 (1725) shared similar sentiments. The opening pages discussed almanacs and calendars. On the front cover, for example, there was a note to readers:

> The cutting of this book disseminates and clarifies the hidden mysteries of the Emperor's Calendar, the detailed explanations of the Comprehensive Book, and the secrets involved in geomancy (lit. the mysteries of yinyang in buildings and graves). It combines the annual spirits, the monthly generals, the daily luminaries, and hourly animals (i.e. the zodiac). It allows one to recognize inauspiciousness and discern auspiciousness. These elements have been gathered and compiled in this book and have become this volume in order to circulate in the world. Anyone who on occasion needs to make a day selection can open the volume, see, and understand. They do not have to go to the trouble to go out and seek someone else's services. If one calls on the work like an artisan refining his craftsmanship, the user will find it exceedingly convenient. That is why it is called a "Comprehensive Book for Management and Useful Things". It dares not have any errors. May the reader inspect its contents carefully.
>
> 是書之刻，發明皇曆之隱微，通書之詳載，以及陽宅陰基之秘，年神月將日曜時禽之統，領審凶辦吉，依書所列匯纂成帙以行於世，凡有選擇，開視了然，無煩外訪，工良心苦所關召用者甚便，故曰辦用通書，不敢有異同也，閱者其鑒諸。[39]

The almanac served as a kind of guide to life. If one previously had had to pay experts to make decisions about future planning, the publication of the almanac now took that expert knowledge and rendered it accessible to the general reader. In his preface to this volume, Mr. Huang of the Suihan tang 歲寒堂 compared the almanac to the oral traditions and transmitted teachings of classical commentators. The calendar was like the text of the Classical Canon, and the almanac was like the commentaries. It interpreted the calendar. This publication relied on the imperial

[38] Zhang, *Da Qing Kangxi Wu Shi Wu Nian Sui Ci Bing Shen Bian Lan Quan Tong Shu*. Preface, 1a-1b

[39] *Da Qing Yongzheng Er Nian Ci Jia Chen Bian Lan Xi Kou Tong Shu* 大清雍正二年歲次甲辰便覽溪口通書 (1725), 18766, National Library of China.

Shixian calendar, but it also contained the knowledge derived from studying planetary motion. This was why the book appended information to time and made the calendar useful for the public.[40]

Commercial publishers, therefore, distinguished between almanacs and calendars as being complementary yet different in purpose. Almanacs were like calendars in that they compiled information about days and months in lists and tables. But they went beyond calendars because they included qualities or extra-information that allowed individuals to make informed decisions about everyday life and the future. It was this secondary function then that enabled almanacs to provide a technical source of information about calendar systems and time reckoning.

Almanacs also served a practical, intermediary role. In addition to the lofty statements in prefaces, these early compilers provided an important service as information brokers in explaining new calendar knowledge. Almanacs published information that connected the traditional systems of timekeeping with the new *Shixian* calendar system. For context, the *Shixian* calendar updated several standards, such as dividing the day in 96 ke instead of the previous 100 ke as well as using 360 degrees instead of 364.25 degrees to measure the 28 asterisms (i.e. the star constellations similar to the Western zodiac). But in the early Qing, these new standards were not widely known. This had consequences for the "star-watchers" involved in geomancy and popular astrology. These individuals depended on these older standards which had been transmitted since the Song and Ming.[41]

The early Qing made efforts to publicize these standards in textbooks. Some of these were very successful like the *Xieji bianfang shu* (1739).[42] These efforts, nevertheless, tended to multiply the possibilities instead of replacing the older standards. This is to say that multiple methods and standards existed simultaneously. Some practitioners, such as Guwalgiya Lianrui 瓜爾佳麟瑞 (?

[40] *Da Qing Yongzheng Er Nian Ci Jia Chen Bian Lan Xi Kou Tong Shu 大清雍正二年歲次甲辰便覽溪口通書* (1725), 18766, National Library of China. Preface, 1a-1b

[41] Stephen Feuchtwang, *An Anthropological Analysis of Chinese Geomancy* (Vithagna, 1974), 206.; Richard J. Smith, *Fortune-Tellers and Philosophers: Divination in Traditional Chinese Society* (Westview Press, 1991), 43, 152.; Lingfeng Lü, "Divination and Its Institutionalization in Pre-Modern China," in *Handbook of Divination and Prognostication in China: Part One Introduction to the Field*, ed. Michael Lackner and Zhao Lu (Brill, 2022), 293-295.

[42] For these institutional changes, see Yi-Long 黃一農 Huang, "Tong Shu Zhong Guo Chuan Tong Tian Wen Yu She Hui de Jiao Rong 通書中國傳統天文與社會的交融," *Hanxue Yanjiu* 14, no. 2 (1996): 165-167.; Lingfeng Lü, "Divination and Its Institutionalization in Pre-Modern China," in *Handbook of Divination and Prognostication in China: Part One Introduction to the Field*, ed. Michael Lackner and Zhao Lu (Brill, 2022), 295-299.

- 1861), explicitly rejected the "New Method" even as late as the nineteenth century because the *Shixian* system made calculations more difficult compared to the "Old Method".[43]

Early almanacs popularized the new standards while developing tools that allowed practitioners to continue to use older standards from the Ming. These books did not include the same information, but there were certain features in common. For instance, basic calendar information was heavily indebted, if not entirely cribbed, from the imperial calendar. Early pages discussed the times of seasonal transition for Shuntian prefecture and Beijing like the imperial calendar. The lists of days and months were also nearly identical. But the calendars added other pages of special content. Some of the content was borrowed from popular encyclopedia and fate calculation literature, but other content was more local and related to the almanac compiler's idiosyncrasies. Some almanacs contained templates that could be used for creating simplified *luopan* geomantic compasses.[44]

Yet in the context of this chapter, one of the most important sections included the ephemeris attached to the rest of the calendar. The three extant almanacs from this early period all contained updated lists of celestial motion. The Qing printed their own versions of these calendars as a part of the imperial distribution (see Chapter 1). But the pages and their layouts in these popular almanacs were based on the Ming models, not the new format created in the Qing. They put two months on each page, and they listed positions in a small column for each of the seven luminaries. These layouts were hybrid tables. The format followed the Ming style, but the data came from the imperial calendars and the new calendar systems. Besides this, as a guide for readers, the almanac printers created a separate column attached to the edge of the chart. It provided reference information from the "Old Method" (i.e. *gufa* 古法), printing the times for seasonal transitions according to older standards. In other words, although the charts recombined the updated data in older styles, the almanac makers provided enough detail that experts in divination could transform the data back into the popular Ming system for everyday use.

According to state reports, the early Qing government was at least somewhat aware of this practice and debated whether they should try to enforce more acceptance of the state standard. The

[43] Tristan G. Brown, "From Fenye to Fengshui: Applying Correlative Cosmography in Late Imperial China," *Journal of History of Science and Technology* 18, no. 1 (2024): 77.

[44] There are three almanacs dated to this period. Zhang, *Da Qing Kangxi Wu Shi Wu Nian Sui Ci Bing Shen Bian Lan Quan Tong Shu*; *Da Qing Yongzheng Er Nian Ci Jia Chen Bian Lan Xi Kou Tong Shu*; Anonymous, *Da Qing Yongzheng Wu Nian Sui Ci Ding Wei Xi Kou Quan Shu* 大清雍正五年歲次丁未溪口全書 (1728), National Palace Museum, https://theme.npm.edu.tw/selection/Article.aspx?sNo=04009319#inline_content_intro.

issue arose in Kangxi 19 (1680) shortly before the Manchus consolidated their control over the southern frontiers. The emperor requested ministers to submit recommendations whether Beijing should start promulgating more copies of the Seven Luminary calendars. The minister Li Wei 李霨 (1625-1684) responded, saying that the state standard would not impact popular practice. Even though the measurements of the new ephemeris had been updated and were considered more accurate than the traditional sources, the ministries admitted that common people consulted almanacs or *tongshu* rather than the state calendar. Because the almanacs provided more information about scheduling, star experts relied on the old methods to determine the 24 seasonal joints. As a result, even if the state tried to distribute more copies of the new data, the problem of integrating the new standards with the old techniques would be cumbersome and not necessarily useful.[45]

Li Wei's comments point to the transitional nature of the early Qing. The new dynasty tried to evaluate its current situation and balance its administrative goals against practical realities. The central bureaucracy published calendars under the same regulations as the early Ming, yet the Qing struggled to stop the private sale of calendars. One of the most important factors limiting these policies was the political reality of the seventeenth century. Even when the Qing did reassert authority over areas that had previously been autonomous, the Shunzhi and Kangxi emperors promoted accommodation as often as coercion.[46] However, by the end of the Kangxi period, the government did take a harder line toward these almanacs and their attendant practices.

Eighteenth Century Changes in Commercial Regulations

Indirect Control

The eighteenth century introduced far more conflict in the relationship between private printers and the state. In the late Kangxi period, the palace authorities became increasingly concerned over maintaining secrecy in government communications. This concern only intensified with the

[45] KX 19.1.12 Zhongguo di 1 li shi dang an guan zheng li, ed., *Kangxi Qi Ju Zhu 康熙起居注* (Zhonghua shu ju, 1984), 482.

[46] The well-known examples of the special literary examinations are good cases that illustrate the state's attempt to lure Ming loyalists into the fold without using violence. Bing Wang, "The Boxue Hongci 博學宏詞 Examinations, Literary Anthologies by Emperors and the Literary Circles during the Kangxi and Qianlong Periods," *Ming Qing Yanjiu* 20, no. 1 (2016): 94–108; Limin Bai, "Shaping the World of Scholars: The Soft Power of Emperor Kangxi (1661-1722)," *Journal of the European Association for Chinese Studies* 1 (2020): 19–57.

expansion of the state under the Yongzheng and Qianlong emperors. These monarchs issued edicts and policies that focused on controlling how and when documents were released to the public and by punishing individuals involved in leaking those documents.[47] These attempts to control the information order also included publishing and books. As Timothy Brooks notes, the literary inquisitions of the eighteenth-century not only targeted manuscripts and printed books, but they also regulated the woodblocks, sheets, and technologies that supported the circulation of this information.[48] Thus, even though calendars were treated as a public good, a necessity for running society, and despite the fact that commercial publications of almanacs were considered useful knowledge, the eighteenth century witnessed a significant change as the government tried to find solutions to centralize the production of calendars.

Rather than relying solely on prohibition, the Qing increasingly sought to regulate almanac production by standardizing the sources from which almanac makers drew and by incorporating almanac functions into official calendars. One of the ways that the government attempted to influence popular culture indirectly was through the standardization of handbooks. After facing conflicts over different sources used to compile this literature, the Qing commissioned new encyclopedic works. These books were supposed to resolve some of the conflicts over the various traditions. The first of these books was called the *Qinding xuanze lishu* 欽定選擇曆書, and it was published in 1684. Then, in 1715, Li Guangdi 李光地 (1642-1718) finished a new volume called *Yuding xingli kaoyuan* 御定星曆考原. These efforts culminated in the *Xieji bianfang shu* (1739) which continued to be printed throughout the rest of the dynasty.[49]

Although the *Xieji bianfang shu* became an important source in teaching day selection, alternative sources persisted despite the imperial efforts at standardization.[50] For example, by

[47] For detailed analysis on the changing ideas of the Qing information order, see Emily Mokros, *The Peking Gazette in Late Imperial China: State News and Political Authority* (University of Washington Press, 2021), Chapters 1, 2.
[48] Timothy Brook, "Censorship in Eighteenth-Century China: A View from the Book Trade," *Canadian Journal of History* 23, no. 2 (1988): 179.; for more on the inquisitions, see Luther Carrington Goodrich, *The Literary Inquisition of Ch'ien-Lung* (Paragon, 1966); R. Kent Guy, *The Emperor's Four Treasures: Scholars and the State in the Late Ch'ien-Lung Era* (Harvard University Asia Center, 1987).
[49] Richard J. Smith, *Fortune-Tellers and Philosophers: Divination in Traditional Chinese Society* (Westview Press, 1991), 50-74.; Huang, "Tong Shu Zhong Guo Chuan Tong Tian Wen Yu She Hui de Jiao Rong, 165-167; Lingfeng Lü, "Divination and Its Institutionalization in Pre-Modern China," in *Handbook of Divination and Prognostication in China: Part One Introduction to the Field*, ed. Michael Lackner and Zhao Lu (Brill, 2022), 299.
[50] Richard Smith discusses some of the ways in which almanac writers continued to cite these sources for their compilations. Richard J. Smith, *Fortune-Tellers and Philosophers: Divination in Traditional Chinese Society* (Westview Press, 1991), 83-84.

1712, Wei Mingyuan 魏明遠 (fl. 1671-1712) published his own competitive manual, called *Xiangji beiyao tongshu daquan* 象吉備要通書大全.[51] This book not only coexisted with the imperial encyclopedias, but it already incorporated adjustments for the new *Shixian* calendar. Over several volumes, it explained how the new calendar worked, and it updated older techniques. It remained in circulation throughout the Qing dynasty as a manual in calendar making. There was even a public notice about it in 1881, because local officials grew concerned that commercial publishers kept publishing it, creating opportunities for private individuals to construct alternative calendars.[52]

There were other competitive handbooks as well. For instance, an early Qing novel mentions a diviner consulting a *Qizheng tongshu* 七政通書 which could have been an updated version of the Ming-era *Qizheng taili* 七政台曆.[53] The physician Wang Weide 王維德 (1669-1749) wrote the *Yongning tongshu* 永寧通書 and compiled handbooks on day selection techniques (e.g. *Bushi zhengzong* 卜筮正宗, 1709).[54] The *jinshi* Ren Duanshu 任端書 (1702-1740) compiled another handbook, posthumously published as the *Xuanze tianjing* 選擇天鏡 (1748).[55] Other sources also mention that almanac makers might consult books like *Xingming xuzhi* 星命須知 as a textbook for their calendar making.[56]

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[51] Wei Mingyuan, *Xiang Ji Tong Shu 象吉通書*, vol. 1, ed. Chen Ming (Zhong yi gu ji chu ban she, 2010), Chen Fangfen preface, 1.; Wei Jian, *Xin Juan Li Fa Bian Lan Xiang Ji Bei Yao Tong Shu Da Quan 新鐫曆法便覽象吉備要通書大全* (1721), 990079328590203941, Harvard-Yenching Library.; Richard J. Smith, *Fortune-Tellers and Philosophers: Divination in Traditional Chinese Society* (Westview Press, 1991), 65

[52] Shenbao 1881.1.16, 2

[53] Huang, "Tong Shu Zhong Guo Chuan Tong Tian Wen Yu She Hui de Jiao Rong," 167

[54] Wang Weide, *Yongning Tong Shu 永寧通書* (1711; Jin zhang tu shu ju, n.d.).; Wang Weide, *Bu Shi Zheng Zong 卜筮正宗* (1709; Beijing, 1904).; Richard J. Smith, *Fortune-Tellers and Philosophers: Divination in Traditional Chinese Society* (Westview Press, 1991), 118-119.; Richard Smith, "The Legacy of Daybooks in Late Imperial and Modern China," in *Books of Fate and Popular Culture in Early China: The Daybook Manuscripts of the Warring States, Qin, and Han*, ed. Donald Harper and Marc Kalinowski (Brill, 2017), 353.; For his relationship to external medicine, see Yuan-ling Chao, *Medicine and Society in Late Imperial China: A Study of Physicians in Suzhou, 1600-1850* (Peter Lang, 2009), 156-158.

[55] Ren Duanshu, *Xuan Ze Tian Jing 選擇天鏡* (1748), 990080512280203941, Harvard-Yenching Library.; Richard J. Smith, *Fortune-Tellers and Philosophers: Divination in Traditional Chinese Society* (Westview Press, 1991), 83, 90-91.; Richard Smith, "The Legacy of Daybooks in Late Imperial and Modern China," in *Books of Fate and Popular Culture in Early China: The Daybook Manuscripts of the Warring States, Qin, and Han*, ed. Donald Harper and Marc Kalinowski (Brill, 2017), 353. Ren Duanshu's poetry is compiled in another work. Ren Duanshu, *Nan Ping Shan Ren Ji 南屏山人集*, Xuxiu Siku Quanshu 續修四庫全書 1441 (1759).

[56] This text is cited in the Zhi Tianmao 智天豹 legal case, a physician accused of selling an unorthodox almanac. Shanghai shu dian, *Qing Dai Wen Zi Yu Dang 清代文字狱档* (Shanghai shu dian, 2011), 255-261. There is a popular edition of this book in the Harvard collections. Anonymous, *Xin Juan Zeng Bu Shi Xian Tai Li Xiu Li Xuan*

In addition to handbooks, the central bureaucracy attempted to control the popular knowledge associated with almanacs by covering this content in the calendar. The Kangxi emperor began this process with specific calls on the Astronomical Bureau to incorporate information from the almanacs.[57] In Kangxi 56 (1717), the Ministry of Rites officially implemented day activities into the calendar.[58] With this regulation, the imperial calendars for the emperor and the people's calendar had to include these activities (see Table 2-1). Although earlier calendars had included aspects of this information, the policy now made this a part of its "almanac"-like features. They tried to make the imperial calendar even more explicitly representative for daily use.[59] In short, the process of compiling state calendar data became increasingly concerned with almanacs. The state calendar was intended to be the authoritative starting point.

Table 2-1: Comparison of Activities in Imperial versus People's Calendars. Source: Yongzheng, Huidian, j. 264, 31b-33b

Analytic Categories	Imperial Calendar	People's Calendar
Governance & Statecraft	*Promulgate Edicts* *Grant Amnesty* *Bestow Favors* *Granting Imperial Patronage* *Conduct Provincial Affairs* *Bestow Ranks and Honors* *Present Memorials to Emperor* *Dispatch Troops* *Pacify Borders*	*Send Memorials* *Visit Officials*
Rites & Religion	*Perform Sacrifices* *Pray for Blessings* *Cappings*	*Perform Sacrifices* *Cappings*
Social & Family Life	*Marriage Ceremonies* *Marry Off Children* *Recognize Family Members* *Seek Heirs* *Enter School* *Marriage Horoscopes*	*Marriage Ceremonies* *Marry Off Children* *Recognize Family Members* *Visit Relatives and Friends* *Travel* *Conduct Burials* *Bone Cleaning Ritual*
Domestic & Personal Care	*Bathe* *Get Shaved / Haircut* *Clip Fingernails/Toenails* *Clean the House* *Move Homes*	*Bathe* *Get a Haircut* *Medical Treatment* *Move Homes*

Ji Xing Ming Xu Zhi 新鐫增補時憲臺曆袖裏璇璣星命須知 (1875), 990090672470203941, Harvard-Yenching Library.

[57] *Yongzheng Da Qing Hui Dian 雍正大清會典*, Jindai Zhongguo shiliao congkan san bian (1985), j. 264, 31a, 15663 ff.

[58] *Yongzheng Da Qing Hui Dian 雍正大清會典*, Jindai Zhongguo shiliao congkan san bian (1985), j. 264, 31b-33b, 15664-15668.

[59] In Yongzheng 5 (1727), they added even more regulations. The new regulations included taboo days, which had previously been recorded in the almanacs. *Yongzheng Da Qing Hui Dian 雍正大清會典*, Jindai Zhongguo shiliao congkan san bian (1985), j. 264, 33b-34a 15668-15669.

	Prepare Bedding *Seek Doctors for Illness*	*Prepare Bedding* *Sweep the House*
Commerce, Labor & Infrastructure	*Open Markets* *Sign Contracts* *Conduct Business* *Sow Seeds* *Graze Animals* *Start Construction* *Repair Palaces* *Build Dikes/Embankments* *Renovate City Walls*	*Open Markets* *Sign Contracts* *Conduct Business* *Sow Seeds* *Graze Animals* *Start Construction* *Break Ground* *Demolish Buildings*

Direct Control

The changes to the state calendar and the publication of textbooks were relatively indirect approaches towards controlling commercial publishers. The government also pursued more direct approaches to control almanac publishing. Starting from the early Yongzheng reign, local magistrates argued that the government needed to intensify its regulation of these printers. Almanacs existed in the grey area of government printing. They were not technically forgeries nor pirated documents, because they changed the content and were based on other sources of knowledge that complemented the state calendar. Nevertheless, they were similar to forged documents, because they circulated without state seals. Government officials worried that in tolerating almanac publishing, the central government forfeited its legitimacy among the people, and since the state calendar started to provide more of the individual almanac information, the need for almanacs appeared to be less significant over time.

Thus, one of the earliest arguments for direct control came from an official named Heshuose 赫碩色 (dates unknown). Heshuose submitted a memorial to the emperor that called on the government to devote more energy to controlling the privately printed calendars and almanacs.[60]

> In the provinces of Jiangnan, Zhejiang, and Fujian, the calendars used by the common people are all calendars and almanacs that are privately printed without official seals. Today, all throughout the land, everyone respects the start of the year promulgated by the imperial calendar. How is it fitting to allow private calendars to circulate publicly? I request that we prohibit the circulation of private calendars in every province and send an edict to all provincial treasuries to partner with merchants to sell government calendars using the authorized seals. Then, all

[60] Carole Morgan includes a French translation of this material in her article on printed calendars Carole Morgan, "De l'authenticité Des Calendriers Qing," *Journal Asiatique* 271, nos. 3–4 (1983): 370-372. This translation is generally accurate, but I differ with several passages and offer my own interpretation here.

> the common people will have government calendars to peruse, whereas the number of almanacs and private calendars will decrease.
>
> 江南浙閩等省，民間所用曆，日多係無印私曆及通書等，今薄海内外莫不遵奉正朔，豈宜令私曆公行，請將各省私曆徧行嚴禁令，各佈政司將用印官曆交與貿易人發賣，則民間俱有官曆觀看，通書私曆自廢.[61]

In this memorial, Heshuose introduced two important policy directives regarding calendars and almanacs. First, he argued that the state needed to increase its control over calendar printing because almanac printing violated the principle of state legitimacy which was the principle behind the statutes on calendar seals.

To clarify this claim, it is worth recalling the legal language concerning forgery and printing. Earlier dynasties had passed multiple restrictions on calendar printing. The most complete version was under the Ming, and it was printed on the front of calendars. It classified state calendars as bureaucratic documents which required government seals. Violators were liable if they printed the official calendar without any seal, or if they tried to forge a government seal to create fake authentication. As Mark McNicholas has shown, common folk did indeed engage in this practice. There were many cases of forged seals to produce official documents or even impersonate a government official.[62] The concern about documents and authentication was genuine.

But were almanacs calendars? As noted above, almanac makers did not believe they were. Instead, they saw their books as complements to calendars more akin to commentaries. Almanac compilers relied on public calendars, but they used their training – or worked with someone who had that training – and published new documents that updated and informed people for different purposes. From a legal standpoint, almanac makers could deny that almanacs were state calendars published without official authorization. But this argument became less convincing in the 1720s. As the government improved its management of almanac information, almanac makers could no longer argue that their interpretations were as original as they previously had been. Furthermore, as any quick view of almanacs makes clear, the design and structure of the almanacs was indeed

[61] Xi Yufu, *Huang Chao Zheng Dian Lei Zuan* 皇朝政典類纂 (Tu shu ji zheng ju, 1903), j. 415, 4a.
[62] Mark McNicholas, *Forgery and Impersonation in Imperial China: Popular Deceptions and the High Qing State* (University of Washington Press, 2017).

heavily indebted to state calendars if not outright copied. So, in his proposal, Heshuose was suggesting that it was time for the government to enforce the regulations – the statute was printed on the front cover after all – and treat almanacs as violations of the documentation and authentication procedures.

Secondly, in addition to bringing more attention towards private calendars and almanacs, Heshuose offered a solution for collaboration. While the government sent copies of the calendar to the provincial offices, Heshuose suggested that the government should allow the private makers to print with the official calendar. To ensure that these prints aligned with the state practices, they simply needed to bring their new prints to the local magistrate's office and receive the seals to authenticate the calendars. This arrangement would promote the use of the official calendars, and it would simultaneously allow the government to oversee these commercial printers.[63]

This recommendation became official policy. Yongzheng responded to the proposal with an edict calling on local officials to search for and investigate privately-published calendars. He encouraged officials to create these public-private partnerships to increase the circulation of the official calendar. Since calendars were important for determining the auspicious days for marriage, construction, travel, and markets, he accepted that public and private partnerships would facilitate the wider circulation of state calendars. Although private calendar printing did fill this need, the emperor accepted that the system required more government management because such pirated editions or private calendars were ultimately against the law.[64]

Nevertheless, new facts surfaced shortly after this deliberation which challenged the implementation of these partnerships. These facts showed that local printing of the state calendar overlapped with fees collected by lower-level administrators as a part of secondary taxes. The Yongzheng Emperor became personally involved in multiple cases on these issues of fiscal reform.[65] For example, the emperor intervened in one such case from Shandong Province in 1727.[66] The district had fallen into serious deficits. There were multiple reasons. According to the emperor, many officials would arrive to a new site and would discover that their predecessor had

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[63] The practice was similar to the arrangements that were simultaneously being made with gazette publishing for the release of other types of government information and documents. Emily Mokros, *The Peking Gazette in Late Imperial China: State News and Political Authority* (University of Washington Press, 2021), 66.

[64] 朕以私曆偽書律應嚴禁而庶民之家凡婚嫁興造遷移開市之事得觀覽官曆以爲選日擇吉之用又於民情甚便是以允從部議. Xi, *Huang Chao Zheng Dian Lei Zuan*, j. 415, 4a.

[65] Madeleine Zelin, *The Magistrate's Tael: Rationalizing Fiscal Reform in Eighteenth Century Ch'ing China* (University of California Press, 1984), esp. Chapters 4, 6.

[66] Zelin, *The Magistrate's Tael,* 79-80.

not fixed the accounts. But they would not say anything to maintain political alliances and out of fear of being accused of the problem themselves. In other cases, the official would try to raise funds through secondary charges and fees on services that were supposed to be public responsibilities, and these fees created dissatisfaction and anger from local populations. The emperor wrote, "When the flesh and blood of the common people is used to rectify the deficits of the officials, how can there not be hardship in the countryside? I am deeply concerned about these abuses."[67]

Due to these audits, the central government realized that the distribution policies for the calendar were inadequate, and these failures explained some of the reason why private calendar printing persisted. According to an edict from 1729, the Yongzheng emperor proclaimed that he had received reports that the new calendar distribution policies had not been implemented correctly. Although magistrates had tried to create partnerships, the prices of calendars had increased. Calendars were considered a necessary item for everyday use. These price increases were serious problems. In the reports, he had heard that the increases had to do with the connection points between the magistrate office and the printers. Since the magistrates used the clerks, that is the yamen runners, to manage these local communications, the clerks charged fees to the commercial printers who in turn passed this cost on to consumers. The prices had risen such that the country folk said that the government took an extra 3 fen (almost double the price) of the calendars.[68]

This moment led to several defining solutions. On the one hand, the Emperor instituted a policy that the central treasury would cover the expenses of calendar printing in the provinces because it was a fairly small cost (reported to be only 7,000 gold pieces in total for the entire printing endeavors) compared to the other budgetary issues.[69] But more importantly, the Ministry of Rites agreed to permit sales and allow printers to reproduce the calendar under certain conditions. These decisions were particularly revealing about the government's practical issues and desire to increase calendar production while minimizing the production of almanacs and unauthorized calendars. For instance, the Ministry stated that printers had to prioritize the government quotas first. Since the government had to provide the calendars for government offices

[67] Translation from Zelin, *The Magistrate's Tael*, 80.
[68] Xi, *Huang Chao Zheng Dian Lei Zuan*, j. 415, 4a-4b.
[69] Xi, *Huang Chao Zheng Dian Lei Zuan*, j. 415, 4b.

and military officials, the state had a large responsibility to fulfill, and printers had to help the government meet this supply before any other commercial activity. But once the complete orders were verified by the fourth month of the year, commercial printers could visit government offices and request to use the woodblocks to create their own calendars. The only stipulation was that the calendars had to receive government seals from those local offices to authenticate the calendars. This in turn introduced a policy that allowed a certain level of mixing almanac information with official calendars as long as the commercial printers worked alongside the government.[70]

The Ministry created recommendations on additional issues that were not necessarily stated in the original deliberations. The Ministry stated that block carvers had some privileges in this system. If they collected the paper and ink themselves, they were allowed to make their own copies of the calendar and sell it so long as they also collected the seals. The same went for other commercial print houses. They were allowed to sell more calendars if they paid for the labor and supplies, and if they received the right seals. The only limitation that was placed on these sales then was the upper price limit. Since calendars were to be treated as a public good, private sales of calendars could not exceed 0.12 taels.[71] Direct control therefore did not mean the wholesale elimination of private calendar printing; rather, it meant transforming commercial printers into supervised participants in the state's calendrical order.

Legal Cases

What were the impacts of the new policy? On the one hand, the policy provided a template for coordinating public and private printing. But the policy did not resolve the biggest problems, i.e. management and forgery. Even though the new policy allowed for commercial printers and even carvers to make a profit on printing calendars, the concern over state legitimacy and forgery continued to impact how magistrates ruled and evaluated different cases involving privately printed calendars and almanacs. The following four criminal cases demonstrate the challenges involved in managing different situations related to private calendars and the state. Together, these cases show that officials distinguished among several kinds of calendrical offenses: unauthorized

[70] *Qin Ding Da Qing Hui Dian Ze Li* 欽定大清會典則例, SKQS (1764), j. 62, 4a-4b.
[71] *Qin Ding Da Qing Hui Dian Ze Li* 欽定大清會典則例, SKQS (1764), j. 62, 4a-4b.

reproduction, forged authentication, illicit compilation, and possession of calendars linked to heterodox religious networks.

Case 1: Xing Huozi (1735). One of the earliest cases concerning illegal calendar printing appeared in the routine memorials on punishments from 1735. Coming from Jiaohe county located near Beijing, the two farmers decided to sell calendars to make extra money. According to the accounts, Xing Huozi 邢豁子 was the ringleader. He recruited the other farmer to his plan. Xing commissioned his partner to travel to Beijing and find printers with connections to the Imperial Astronomical Bureau. Using his connections with printers, this farmer from Jiaohe was able to purchase a draft copy of the upcoming calendar. He brought the calendar back to their village. In their village, Xing Huozi then hired two additional carvers to help them create the materials they needed to sell their calendars. One of the carvers worked in the folk print networks, as he normally made door-god images. This person was hired to carve the blocks for the main calendar. The second carver was hired to engrave a seal in imitation of the seal of the Astronomical Bureau.

Using the blocks and the fake seal, Xing and his partner hired book printers to produce a run of 6000 copies of the calendar. They sold their copies to a local bookstore wholesale. This bookstore became the main center for distributing these calendars. As the calendars circulated more widely in the area, the authorities were informed about the calendars and the fake seal. They tracked down the partners through the bookstore and arrested the various people involved. The printers claimed to be illiterate, and the government accepted this claim as the most serious crime was not the printing but the carving of a fake government seal.[72]

Case 2: Zhou Er (1743). Another case from 1743 presented a similar situation, although the authorities discovered printing at a much larger scale. This case involved petty merchants in today's Hebei province. The instigator was a man named Zhou Er 周二 who had previously made his living selling brushes. The other figure was named Yu Zaizhong 俞在中. Although Yu hailed from Jiangning county in Jiangsu province, he had moved to the capital to work as a block carver. Zhou and Yu became acquainted because of Zhou's traveling business. Zhou claimed that his business struggled. Because he had made the acquaintance of Yu, he decided to try to print

[72] Xingke tiben, qita lei, QL 1.8.28, j. 321 as cited in McNicholas, *Forgery and Impersonation in Imperial China*, 110-111.

calendars. Yu then purchased a calendar from a student in the Astronomical Bureau and then hired another carver to accompany him back to Zhou's village. There, the two proceeded to carve large and small format calendars. Zhou asked Yu to carve a wooden seal for him so that he could authenticate the calendars. Zhou then hired a local printer to work with him on a monthly wage to produce both large and small size calendars that he sold for 0.1 and 0.04 taels.[73]

By the tenth month, as Zhou Er sold his calendars in regional markets, another brush merchant named Zhuang Da 莊大 asked to collaborate with Zhou Er and create his own calendar business. On the sixth day of the tenth month, Zhuang Da purchased small calendars from Zhou Er at the Dezhou market, an important regional market in Western Shandong. Using that calendar, Zhuang Da then hired out more woodblock carvers and printers to create more copies. Although he sold his calendars for the same prices as Zhou Er, authorities later noted that the calendars were slightly different.

These two sets of printers were arrested a few weeks later, and all their copies were confiscated. Following the investigation, the officials accused the block carvers as being the most negligent. Although Zhou Er and Zhuang Da had largely masterminded the printing, the government accepted their claims that they were struggling merchants. In other words, their poor conditions encouraged them to engage in illicit actions. Moreover, the materials that they produced were alterations of the calendar. The confiscated calendars showed that they were not simply copies. They had added material which was said to be "vulgar and common", perhaps illustrations or other elements about the year from the popular tradition. However, the people who were considered the most culpable were the block carvers. They had intentionally forged seals to fake the government seal. While the merchants were recommended to be punished according to lower-level punishments, the block carvers were recommended to be punished to the fullest extent of the law.[74]

Case 3: Zhi Tianbao (1779). Whereas earlier cases involved the commercial printing of the *Shixian shu*, this investigation focused on the compilation of a Perpetual Almanac or the *Wannian shu*. The protagonists in this case were a physician named Zhi Tianbao 智天豹 and his student

[73] Shuhede, "015367," Memorial 奏摺, QL 8.11.21, Grand Secretariat Neige daku dang'an.
[74] Shuhede, "015367," Memorial 奏摺, QL 8.11.21, Grand Secretariat Neige daku dang'an.

named Zhang Jiuxiao 張九霄. According to their depositions, Zhi Tianbao started compiling the perpetual almanac when his business suffered. He had trained as a physician from his father. Earlier in his life, he had run a pharmacy in Qizhou 祁州. But he closed it and started traveling around selling various medications and healing ointments. Because he struggled to make a successful living with this business, he decided to compile a manuscript of the perpetual almanac based on his knowledge of fate calculation. He hoped to use the manuscript to not only receive imperial favor but also publish a book that would be widely celebrated. Zhi Tianbao had previously healed Zhang Jiuxiao's back pain. He also claimed to have received a special visitation from a Daoist immortal in Qianlong 27 (1762) – a claim that Zhi later confessed was a fabrication meant to deceive people. Zhang Jiuxiao offered to help Zhi Tianbao deliver the calendar to the Qianlong Emperor.[75]

However, when the authorities viewed the manuscript, they found multiple discrepancies that violated laws and rituals. On the one hand, Zhi Tianbao made a prediction in his almanac that the Qing dynasty would last for more than eight hundred years, longer than the ancient Zhou dynasty. Yet, Zhi made fatal mistakes. He used the Eight Trigrams to create a set of new reign titles, ritual terms that were only supposed to be proclaimed by emperors. Moreover, he violated name taboos. He used forbidden names and titles from past emperors. Because he was compiling an almanac, he also included several sets of Daoist incantations in the book. One of the most shocking parts of the almanac was his prediction that the Qianlong emperor would die in the 57th reign year. These were no longer errors of just heterodoxy but violations of serious laws about imperial honor. Consequently, even though the Ministry of Punishments recognized that he was a poor person trying to sell a book to make money, which was considered reasonable, he was sentenced to death-by-slicing, the worst possible death sentence in the Qing dynasty reserved for treason. His student Zhang was equally sentenced to severe punishment, death by beheading, and Zhi's wife was sold into slavery as the personal spoils of the governor who captured him.[76]

Upon review, the Grand Council recommended the emperor reduce the sentence in light of the circumstances. In the public notification about the case, the emperor wrote that he was not personally offended by what his ministers had called a "curse" upon his person. If he were to die in the 57th reign year, he would still have been 82 sui, and he would have considered it a long life.

[75] Shanghai shu dian, *Qing Dai Wen Zi Yu Dang 清代文字狱档* (Shanghai shu dian, 2011), 256-258.
[76] Shanghai shu dian, *Qing Dai Wen Zi Yu Dang 清代文字狱档* (Shanghai shu dian, 2011), 257-258.

He did not view the statements as defamatory but something that could be forgiven. Yet none of the other taboo violations, nor the audacity to create such an almanac with reign titles merited additional reductions. Zhi ultimately died by beheading.[77]

Case 4: Liu Zhenyu (1784). The previous cases all involved profit motives. This final example concerns the broader problem of illicit calendars, or calendars that were outside the purview of imperial oversight. In the 1780s, the Manchus sent reinforcements to the northwestern frontier to suppress a violent movement among different Muslim populations in Gansu province.[78] In 1784, the local government discovered the presence of foreign Christian missionaries in the region around Xi'an. The combination of these events led to an intense anti-Christian investigation that extended to several regions, including the area around Beijing and then Shanxi, Shaanxi, Hunan, Hubei, and Shandong provinces.[79]

One of the people arrested in this period was Liu Zhenyu 劉振宇 from Hunan, who was detained because of the calendar found in his home. In his deposition, Liu said that he was not a Christian. But he had recently visited another village and dined with a family who were. The family shared his surname Liu, but they were not relatives. The mother of the family knew that Liu Zhenyu suffered from consumption (i.e. *laobing* 癆病) and that he had followed the dietary restrictions and religious fasting based on the cult of Guanyin, but that it had produced little effect. Since she also suffered from consumption, she recommended he follow the Christian calendar and their fasting schedule instead because it had helped her a little. They gave him a calendar to take home. He wanted to get better. So, he took it and pasted it up on the wall of his home for reference. But a few days later, the district magistrate arrived and arrested him, saying that this calendar was forbidden and illegal.[80]

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[77] Shanghai shu dian, *Qing Dai Wen Zi Yu Dang 清代文字狱档* (Shanghai shu dian, 2011), 259-260.; The edict was published in the Peking Gazette, and this part of the story happened to be shared by Amiot back to France. Nicolas Standaert, *The Chinese Gazette in European Sources: Joining the Global Public in the Early and Mid-Qing Dynasty* (Brill, 2022), 171-173.

[78] Jonathan N. Lipman, *Familiar Strangers: A History of Muslims in Northwest China* (University of Washington Press, 1997), 103-115.

[79] Lars P. Laamann, *Christian Heretics in Late Imperial China: Christian Inculturation and State Control, 1720-1850* (Routledge, 2006), 64-65.

[80] Zhongguo di 1 li shi dang an guan, *Qing Zhong Qian Qi Xi Yang Tian Zhu Jiao Zai Hua Huo Dong Dang an Shi Liao 清中前期西洋天主教在華活動檔案史料*, vol. 1 (Zhonghua shu ju, 2003), 349.

Because Liu Zhenyu testified that he had received the calendar from a neighboring family, the district magistrate investigated and discovered more material.[81] The family had new liturgical calendars, because they had recently helped smuggle four Western priests into China through Guangdong province via Macao. The Liu family had participated in the network that helped transfer them into the interior of China.[82] The four Italian priests, who were unable to speak Chinese, were caught in Hubei and transferred to Beijing for trial.[83]

These four cases exemplify how the clarification around distribution did not necessarily resolve problems concerning private calendars. On the one hand, ministry officials increasingly distinguished between intentions. Profit motives were understood as a reasonable measure for why traders and merchants might alter calendars and produce their own editions. In two of these cases, the government would have been even more lenient if the printers had not created fake seals to forge authentication. On the other hand, these cases also show that the issues of state legitimacy remained important components for navigating why the government wanted to control these networks. Calendars were associated with heterodox societies. These aspects of calendar making quickly linked calendars to more serious issues of rebellion and social unrest.

Legal Reform

At the beginning of the Yongzheng period, the government refocused on controlling almanacs and calendars. Then, as the government ruled on legal cases regarding calendars throughout the eighteenth century, they came to recognize that the issue of seals was only one aspect of calendar regulation. As a result, the government created updates to the legal code, clarifying that

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[81] Zhongguo di 1 li shi dang an guan, *Qing Zhong Qian Qi Xi Yang Tian Zhu Jiao Zai Hua Huo Dong Dang an Shi Liao* 清中前期西洋天主教在華活動檔案史料, vol. 1 (Zhonghua shu ju, 2003), 349-352.

[82] Zhongguo di 1 li shi dang an guan, *Qing Zhong Qian Qi Xi Yang Tian Zhu Jiao Zai Hua Huo Dong Dang an Shi Liao* 清中前期西洋天主教在華活動檔案史料, vol. 1 (Zhonghua shu ju, 2003), 368-377.

[83] Zhongguo di 1 li shi dang an guan, *Qing Zhong Qian Qi Xi Yang Tian Zhu Jiao Zai Hua Huo Dong Dang an Shi Liao* 清中前期西洋天主教在華活動檔案史料, vol. 1 (Zhonghua shu ju, 2003), 369. For additional perspectives on this case and its context, see Hu Zhongliang, "Cong Qing Dai Dang an Kan Bai Nian Jin Jiao Shi Qi Xi Yang Tian Zhu Jiao Zai Hua Nei Ji de Qian Shen Ji Sheng Cun Zhuang Tai 從清代檔案看百年禁教時期西洋天主教在華內擊的潛滲及生存狀態," 故宫博物院八十华迺暨国际清史学术研讨会论文集 (Beijing), 2006, 328-329. Eugenio Menegon, "Wanted: An Eighteenth-Century Chinese Catholic Priest in China, Italy, India, and Southeast Asia," *Journal of Modern Italian Studies* 15, no. 4 (2010): 502–18.; Wu Boya, "Cai Bo-Duo-Lu Shi Kao 蔡伯多禄事考," in *Zong Jiao Yu Li Shi: Di Wu Ji: Wan Ming Yi Lai de Tian Zhu Jiao Yan Jiu 宗教与历史：第五辑：晚明以来的天主教研究*, ed. Tao Feiya and Xiao Qinghe (Shanghai da xue chu ban she, 2016).

punishments like beheading had to be evaluated in terms of intentionality. If the perpetrators were involved in calendar selling for profit, this was quite different than being involved in calendar printing related to heterodoxy. Legal reforms therefore exposed a widening gap between the formal prohibitions and the administrative tolerations of commercial calendar printing.

The law code slowly started to reflect these changes in imperial attitudes about private calendars, although the rules were rarely explicit about this. In Qianlong 25 (1760), the state updated the regulations about seals again with greater clarity about how to deal with different types of perpetrators. They emphasized that the seal carver was the most liable, but they added new statutes stating that the "instigators" of the affair were equally eligible for severe punishment. But while previous rules had given harsh punishments towards the accomplices or the underlings, the new statutes provided lenient punishments for followers.[84]

Besides gradations, the new statutes implemented intentionality as an important factor to consider. There were differences between money-making motives versus orthodoxy. In other words, if a small-town trader had carved a seal because of his goal to get a profit, this was still a crime but was considered worthy of forgiveness and leniency due to that person's circumstances. However, if one had started to produce seals and documents to impersonate the government or make claims to an alternative government, then the crime became as severe as initially written.[85]

While mentioned in the context of forging seals, this policy of accommodation for intentionality and the status of a person whether illiterate or a petty trader seeking a quick profit had already entered legal interpretations under the Yongzheng reforms. Because of this idea for taking into consideration the situational context of the accused, commercial regulations over calendars also participated in this debate. In a memorial submitted by Tang Suizu 唐綏祖 (1686-1754) in Qianlong 5 (1740), he argued that the government should simply permit private calendar printing regardless. Because the provincial offices were unable to distribute calendars to rural areas, they already relied on commercial printers. But commercial printers were worried about being punished if they did not get the proper seals. They instead used red and yellow ink with a smudge on the front. This avoided the law in a certain way, because it was not technically "forging a seal", and they were just copying official calendars. Since commercial printers were also

[84] Wu Tan, *Da Qing Lü Li Tong Kao Jiao Zhu* 大清律例通考 (1785; Zhongguo zhengfa daxue chubanshe, 1992), 930-931.
[85] Wu, *Da Qing Lü Li Tong Kao Jiao Zhu*, 930-931.

innovative in finding ways to change the size and shape of the calendar to make it cheaper, he also thought it was excessive to punish them with such harsh measures.[86]

At the official level, the statutes only responded to this with lowering the punishments. Instead of beheading, they lowered the punishments to exile. But according to an internal document from Qianlong 9 (1744), the central government admitted that the policies already allowed for commercial printing without seals. The document stated that calendars were supposed to represent imperial authority, and they were necessary. But the policy from the Yongzheng period that permitted artisans and commercial printers to sell calendars had opened the door for wider printing. Since many of these calendars used red and yellow ink instead of a seal, they were not in reality "forged" documents. So long as the commercial merchant focused on profit-making and did not try to create a fake seal, the government passively allowed it. This document then ended with the remark that the law should simply delete the statutes about forging calendars because it was no longer useful.[87]

Although the harsh statute remained on the books, the central government ended up taking a noncommittal approach towards certain types of calendar printing. The most important factor in assessing these cases became security and state legitimacy. Even though the law retained strict regulations, these regulations were only necessary for cases like the Catholic calendars or the case of Zhi Tianbao, when the almanac offended imperial honor. In the debate over how to control the calendar market, the state therefore moved toward a more indirect method: tolerating commercial printing when it served public demand, while reserving harsh punishment for cases that implicated sovereignty and legitimacy.

Nineteenth Century Commercial Regulations

Despite the permission granted towards commercial printers, the mid-century reforms were not the final word on state involvement in regulating calendars and almanacs. The reforms were limited in their geographic application, and they were largely buried in the legal literature. Despite the recommendation to remove the statements about beheading, the front covers of calendars continued to repeat this information into the nineteenth century. Over the course of the century, the government focused on refining these goals and dealing with issues of legitimacy.

[86] Wu, *Da Qing Lü Li Tong Kao Jiao Zhu*, 931.
[87] Wu, *Da Qing Lü Li Tong Kao Jiao Zhu*, 931.

The first major turning point occurred, in 1816, when the government extended earlier interpretations to make open and commercial regulations actual policy for the state. However, this did not mean a total free market. Ironically, while commercial printers were granted far more autonomy, religious calendars now became the greatest concern. Religious almanacs challenged the authority of the state and placed the issue of almanacs back into the older concerns over heterodoxy. By the end of the nineteenth century, the opening of Treaty Ports raised new problems over how to deal with heterodoxy. Commercial printers and religious printers used the freedom of information and the opening of markets as a means to compete with imperial calendars and appeal to new audiences. Through these debates, the private production of calendars became a battleground over territory and legitimacy.

The Case of Huang San, 1816

The year 1816 was a turning point in imperial regulations. Although the government had already become more lenient in its interpretations about private printing and almanacs, the 1816 case extended these reforms to an empire-wide policy. The case revolved around a network of printers and carvers, but it implicated almost all the roles involved in calendar production. Due to the scale of the issue, the government reassessed the statutes on private printing. The case clarified the goals, i.e. that distribution was the most important part of the process, but that commercial printers needed to use the state standards. This case brought a new openness towards commercial printing that especially allowed printers in South China to return to their historical almanacs and print for larger audiences. Nevertheless, the case did not change the concerns over legitimacy.

The case came to the attention of the government near the end of the ninth month in 1816 due to an artisan turning in the group. A carver from Beijing reported to the neighborhood police that a group of forgers were selling calendars in advance of the distribution ceremony. Distributors had access to woodblocks from the fourth month onwards, but they were not supposed to make the calendars available for sale until after the first day of the tenth month when officials conducted the season-receiving ceremony in the capital and the provinces. Given those regulations, the carver reported that the Wenruizhai 文瑞齋 bookshop located near the Coal Market Bridge 煤市橋 in the capital was copying woodblocks, printing, and distributing the next year's calendars before the

tenth month. This carver also claimed that the merchants were able to do this because they had forged an official seal which they were using to authenticate their calendars.[88]

These were serious allegations, and the government acted swiftly. Officials arrested the people involved within a few days and extracted confessions from the different carvers and printers who were selling the calendars. According to these reports, the ringleader was a man named Huang San 黃三, a printer who was registered in Tangyi 堂邑 county in Shandong province, an area known for skilled carvers and printers.[89] In his deposition, Huang San said that he traveled to Beijing in the fourth lunar month when the Astronomical Bureau had started to distribute the models to provinces for printing. While in the capital, he learned about an opportunity to sell calendars through a friend named Wang Dehai 王得海, who was also from Tangyi. Wang said that he knew the head artisan for the Astronomical Bureau who wished to sell a copy of the calendar. Huang and Wang decided to collaborate and agreed to split costs. They purchased the calendar, and Wang carved eighteen woodblocks which he then delivered to a bookshop where Huang had previously worked.[90]

After Huang picked up the woodblocks, he hired more workers to help him transport the blocks to another county where they started printing calendars. Initially, they printed 13,000 copies. They had sold 12,000 when they decided to split up because they needed new blocks. Huang sent some of his trusted workers back to Beijing to commission more blocks to carve, because the original blocks had already become blurry from printing. Huang's friend worked with another carver in the capital to produce the new woodblocks, but they had only completed eight blocks before they were arrested. Once Huang heard about their arrest, he came to Beijing to turn himself in.[91]

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[88] Jide and Zhuo Bingtian, "056490," Lateral Communication 移會, JQ 21.9.27, Grand Secretariat Neige daku dang'an.

[89] Zhang Xu, "049609," Memorial 奏摺, JQ 21, Grand Secretariat Neige daku dang'an. The Tangyi village produced an important source of seasonal and sojourning labor for woodblock carving and printing in Beijing and its neighbors. Wu Yunmi, "Liaocheng Ke Shu Yu Chu Ban Ye de Xing Ai Gai Kuang 聊城刻书与出版业的兴衰概况," in *Shandong Wen Zhi Zi Liao Xuan Ji 山東文史資料選輯*, vol. 4, ed. 中国人民政治协商会议山东省委员会 Zhongguo ren min zheng zhi xie shang hui yi Shandong wei yuan hui (Shandong renmin guangshe chuban, 1982), 120.; Jin Ziyuan et al., "Liaocheng Si Da Shu Zhuang 聊城四大書莊," in *Liaocheng Wen Shi Zi Liao 聊城文史資料*, vol. 4, ed. 政协聊城市文史资料研究委员会编 Zheng xie Liaocheng shi wen shi zi liao yan jiu wei yuan hui (Nei bu yin shua, 1987), 95, 101.; Zhaohui He, "Expansion, Integration, and the Limits of Commercial Publishing in North China during the Qing Dynasty: Taking Dongchang Prefecture as an Example," *East Asian Publishing and Society* 12, no. 1 (2022): 6.

[90] Zhang, "049609."

[91] Zhang, "049609."

Throughout his interrogation, Huang insisted that he simply had wished to collect a profit and that he had not intended to do anything wrong. The government, however, was not entirely convinced. He had been accused of copying an imperial seal, but he denied having commissioned one. He insisted he was ignorant of the law concerning seals, even though he cleverly avoided the forgery laws. Instead of using a forged seal, he had used a blank piece of wood with a rough face. He rubbed it on the page to create blurry impressions with red ink. This mark made it look like a version of an imperial seal, but it was not an actual forgery. It helped him pass the prints off as official calendars. The investigators determined that he was telling the truth. Looking closely at the materials they had collected from him and the models of the calendars, they agreed that he had not forged the government seal.[92]

Although this discovery allowed the ministry to treat Huang under different statutes than forgery, they still found serious issues with his calendars and actions. There were discrepancies between his calendar and the state calendar. Some of the stems and branches seemed to be different. The Ministry of Punishments asked for additional review from the Astronomical Bureau and the Department of Astrological Signs regarding whether the calculations used to determine the various stems and branches used in the calendar were accurate.[93] Upon review, the Astronomical Bureau determined that Huang had indeed changed those terms leading to a particular form of error in the calendars.[94]

This case had several consequences. In the immediate aftermath, most people were punished. Huang and the people who were working for him were all found guilty of pirating calendars and forging documents, although they were given lighter sentences than beheading.[95] The leadership of the Astronomical Bureau, including the Western missionaries who still worked on the staff at the time, were demoted and had their honors removed. They were accused of leaking government documents and not managing the workers properly.[96]

More significantly, the case renewed attention to the interpretation of the statutes and to the practical problems of delivering calendars through commercial agents. The popular practice of avoiding seals, combined with the government's need to rely on commercial printers, made strict

[92] Zhang, "049609."
[93] Zhang, "049609."
[94] Zhang, "049609."; QSL JQ 21.11.5
[95] Zhang, "049609."
[96] Songyun, "049676," Memorial 奏, JQ 21.10.03, Archive of the Grand Council 軍機處檔案, National Palace Museum.

enforcement difficult. The newly-appointed director to the Astronomical Bureau Yishao 奕紹 (1776-1836) conducted an internal review and wrote about the difficulty to make significant reforms. In his report, he explained that the printing demands often required carvers to produce multiple sets of blocks because blocks would not last long enough for the printing requirements. This meant that in practice carvers always had blocks that gave them leverage to sell the materials for producing calendars. Furthermore, because the state was responsible for so many calendars in the central provinces, they struggled even more to reach quotas.[97] Yishao recommended that the government relax the regulations and allow more commercial support.

The government also evaluated the language used on the pages. Since the earlier pages had included the warnings about beheading, the government led an investigation in the historical precedents to determine how and why the wording had changed over time. Because the policy had shifted so much in favor of allowing private printing, internal reports suggested that the government simply remove all these warnings and materials.[98]

The case resulted in the expansion of these commercial permissions while clarifying what constituted a violation. Following this case, the central government allowed the concept of provincial distribution and commercial relationships to be made accessible for the entire state. All the blocks would be made publicly available for merchants and print shops. These communities were supposed to work with the government office and receive a stamp from the government's seal to approve the calendars. But the government noted that the most important factors were following the standards. These were the standards based on the imperial mathematics curriculum and the techniques laid out in the textbooks on astrology. While calendars could be printed without the warning about beheading, they still needed to state that they were compiled according to those standards.[99] This continued note about the imperial textbooks served as a signal to private makers to ensure that if they were going to create private almanacs and calendars, the procedures that generated the calendar information had to be based on the imperial models, although they had more leeway about what other kinds of elements they were going to include in their private materials.

[97] Yishao, "049970," Memorial 奏, JQ 21.11.17, Archive of the Grand Council 軍機處檔案, National Palace Museum.
[98] Yishao, "049970".
[99] Yishao, "050052".; Xi, *Huang Chao Zheng Dian Lei Zuan*, 415, 8b.

These changes were significant because they opened up a commercial market around calendars. Now, since the government accepted many commercial practices, they allowed for individual merchants to generate new variations of the calendar as long as the central calendar elements were connected to the imperial standard. Even if Chinese empires had largely failed at managing this problem, this shift in policy was the first time that it became recognized in law. The government decided to accept the increase in calendars as a means of generating revenue and allowing unofficial calendars to circulate, if they were not pirated.

By accepting a market-oriented solution to relieve some of the government's fiscal and infrastructural burdens, Beijing created a new space for almanacs. While the Astronomical Bureau likely sighed from relief, some critics, like Yu Zhengxie 俞正燮 (1775–1840), bemoaned the change as institutional retreat. Yu was a well-known evidential scholar and even astronomer.[100] He knew that calendars and policy had changed over time. There were even changes in procedures that had led to confusions over the fit and incommensurate definitions of various stems and branches which had ultimately been decided by imperial fiat. But in his perspective, because the government stopped printing the warning about severe punishment for forging calendars, the government granted tacit approval to widespread variation in private printing. They permitted a kind of outpouring of confusing sets of calendar rules. If calendars were supposed to create centralized ritual and scheduling, Yu believed that the government's solution had already generated the opposite effect.[101]

Orthodoxy and Almanacs

Despite Yu Zhengxie's fear, the Huang San case did not mean that the government completely relaxed all restrictions regarding calendars and almanacs. The case upheld state orthodoxy. Huang San was punished not because he had forged a government seal. He was punished because he had inserted errors in the various stems and branch combinations for the year. He had in fact adjusted the calendar copy that he had received. These calculations were essential components of state cosmology. It is this aspect of the calendar then that explains why the Huang San case attracted as much attention as it did. Since at least the 1790s, sectarian movements and secret societies had

[100] Lien-chê Tu, "Yü Chêng-Hsieh," in *Eminent Chinese of the Ch'ing Period: 1644-1912*, vol. 2 (United States Government Printing Office, 1943).
[101] Yu Zhengxie, *癸巳類稿 Gui Si Lei Gao* (商務印書館出版, 1957), j. 12, 474.

become increasingly visible in their resistance to the Qing. These groups often relied on almanacs that challenged the state orthodoxy and called for new temporal orders.

Popular religious movements, including the White Lotus societies and the Eight Trigrams sect, were fundamentally based on a theory of time and political order. These groups shared beliefs in the end of time. Although they had different practices, they generally viewed the world as having undergone periods of destruction and regeneration that occurred over many centuries and thousands of years. Each epoch or *kalpa* was defined by a different salvific Buddha leader who taught the teachings of enlightenment, but whose teachings eventually fell by the wayside and ended in disasters. The believers awaited the coming of the savior who would usher in the new age. According to these teachings, there were three primary *kalpas*: 1) the Glorious Kalpa 莊嚴劫, when a thousand Buddhas appeared in succession; 2) the Wise Kalpa 賢劫, the present age when Siddhartha Gautama brought his teachings to the world; 3) the Constellation Kalpa 星宿劫, when the future Buddha Maitraya would bring a new purification and teaching.[102]

Millenarian teachings did not necessarily call for violent action – they were calm during the seventeenth century and first half of the eighteenth century – but these sectarian movements were involved in several waves of resistance against the Manchus moving into the nineteenth century. An early sign of this opposition appeared during the Wang Lun uprising in 1774. Situated in western Shandong province, this popular movement emerged from teachings about a coming new age and resulted in a swell of violent campaigns against the Manchus. During the uprising, the agitators took over county seats. At the time the government was embroiled in other confrontations along the frontiers, and so they were caught by surprise. It took the emperor more than a month to marshal troops and suppress the rebellion.[103]

More actions occurred during the subsequent reigns. One of the most significant was the White Lotus War, lasting for about twenty years. This war began as a series of uprisings from the highlands and border areas connecting Sichuan, Hubei, and Shaanxi. The banner armies initially struggled to contain the revolts. As a result, the government was forced to rely on the Green Banner

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[102] For millenarian beliefs on time and temporality, see Susan Naquin, *Millenarian Rebellion in China: Eight Trigrams Uprising of 1813* (Yale University Press, 1976), 9-18.; Ma Xisha and Han Bingfang, *Zhongguo Min Jian Zong Jiao Shi 中國民間宗教史* (Shanghai ren min chu ban she, 1992), 102-164.; Barend J. ter Haar, *The White Lotus Teachings in Chinese Religious History* (Brill, 1992).; Hubert Seiwert, *Popular Religious Movements and Heterodox Sects in Chinese History* (Brill, 2003).

[103] For more details on this uprising, see Susan Naquin, *Shantung Rebellion: The Wang Lun Uprising of 1774* (Yale University Press, 1981).

troops and local militias.[104] Then, in 1813, in the areas around Beijing, the Eight Trigrams societies organized under the leadership of Lin Qing 林清 (? - 1813). He was a charismatic leader who claimed to be the reincarnation of Maitreya. Bringing together a variety of ideologies, including popular religion and the restoration of the Ming, this movement confronted the government and declared itself as having replaced the Qing's Mandate of Heaven.[105] Additional groups, including the Taiping and the Nian rebels, created similar problems. These groups sparked wider revolt, and they shared aspects of these older millenarian ideologies.[106]

Throughout the suppression campaigns, the Qing specifically targeted the almanac publications that were made by these groups. These publications were a combination of published and manuscript artifacts that organized and outlined time for believers. For instance, upon capturing Lin Qing, the generals confiscated his scrolls and religious materials which they then had sent to the emperor. When the Jiaqing emperor read the books, he mentioned one manuscript called the *Sanfo yingjie tongguan tongshu* 三佛應劫統觀通書 as one of the most harmful texts for its unorthodox teachings and anti-Manchu content.[107] This manuscript was then found among other societies as a part of suppression campaigns. In 1815, when the government investigated the Shouyuan 收圓 and Qingcha 清茶 sects for heterodox teachings and promoting anti-state literature, they discovered additional copies of the text.[108] Because of the government's view that this this

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[104] For more details on the White Lotus war, see Bernard J. ter Haar, *The White Lotus Teachings in Chinese Religious History* (Brill, 1992), 250-262.; Wensheng Wang, *White Lotus Rebels and South China Pirates: Crisis and Reform in the Qing Empire* (Harvard University Press, 2014), 37-80.; Yingcong Dai, *The White Lotus War: Rebellion and Suppression in Late Imperial China* (University of Washington Press, 2019). For additional context on these conflicts and local militias, see Philip A. Kuhn, *Rebellion and Its Enemies in Late Imperial China: Militarization and Social Structure, 1796-1864* (Harvard University Press, 1970), 37-49.; Daniel McMahon, "Southern Shaanxi Officials in Early Nineteenth-Century China," *T'oung Pao* 95 (2009): 120–66; Daniel McMahon, "Qing Reconstruction in the Southern Shaanxi Highlands: State Perceptions and Plans, 1799–1820," *Late Imperial China* 30, no. 1 (2009): 85–118.

[105] For details on this rebellion, see Naquin, *Millenarian Rebellion in China*.; Ma and Han, *Zhongguo Min Jian Zong Jiao Shi*, 1025-1091.

[106] For overviews of the Taiping, see Kuhn, *Rebellion and Its Enemies in Late Imperial China*.; Thomas H. Reilly, *The Taiping Heavenly Kingdom: Rebellion and the Blasphemy of Empire* (University of Washington Press, 2004).; Stephen R. Platt, *Autumn in the Heavenly Kingdom: China, the West, and the Epic Story of the Taiping Civil War* (Penguin Books, 2012).; Tobie Meyer-Fong, *What Remains: Coming to Terms with Civil War in 19th Century China* (Stanford University Press, 2013). For studies of the Nian rebellion, see Elizabeth J. Perry, "Worshipers and Warriors: White Lotus Influence on the Nian Rebellion," *Modern China* 2, no. 1 (1976): 4–22.; Elizabeth J. Perry, *Rebels and Revolutionaries in North China, 1845-1945* (Stanford University Press, 1980), 96-151.

[107] QSL JQ 1.9.19

[108] Susan Naquin, "Connections between Rebellions: Sect Family Networks in Qing China," *Modern China* 8, no. 3 (1982): 341-342.; Ma and Han, *Zhongguo Min Jian Zong Jiao Shi*, 602-603; 628-629.; Hubert Seiwert, *Popular Religious Movements and Heterodox Sects in Chinese History* (Brill, 2003), 399-400.; Li Shiyu, *Bao Juan Lun Ji 寶卷論集* (Lan tai chu ban she, 2007), 296-300.

almanac was a treasonous document, local officials were supposed to find any copy of the almanac and destroy it.

Sects used these almanacs to produce calendars that challenged state authority. The Shouyuan sect, for instance, had copies of the almanac as a part of received tradition of the *Jiulian jing* 九蓮經, a popular religious text from the late Ming.[109] Based on these almanacs, the sect produced new calendars. These calendars were titled *Shixian shu*, but in the confiscation inventory, they were listed as "forged" calendars, most likely because they had faked seals and altered some of the content.[110] There were similar examples with the *Wannian shu* or perpetual calendars. Perpetual calendars were important in defining the sources used in stems and branches and in creating lists of imperial reigns. They were almost like cosmological lineages used to justify a particular dynasty's theory of the Mandate of Heaven. Since these sects believed that a new age was coming, ergo a new Mandate, they were creating perpetual almanacs that predicted the end of the Qing dynasty and the foundation of a new set of reign titles and cyclical patterns.[111]

Although local officials tried to eradicate these books, two extant versions of the *Sanfo yingjie tongguan tongshu* have survived; and they provide a glimpse into these popular teachings.[112] These books taught that each *kalpa* was defined by an expanding system of time. In the first *kalpa*, for instance, there were only six months and six hours, while in the second epoch, there were twelve months and twelve hours. Then, in the coming epoch, time would change again where one year would consist of eighteen months, one month of forty-five days, one day of eighteen hours, and the hours divided into one hundred forty-four ke.[113] In consequence, these almanacs challenged the orthodox teachings about the unchanging nature of the heavens. Moreover,

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[109] Ma and Han, *Zhongguo Min Jian Zong Jiao Shi*, 610-619; Hubert Seiwert, *Popular Religious Movements and Heterodox Sects in Chinese History* (Brill, 2003), 502-505.; Huang Yupian, *Po Xie Xiang Bian 破邪詳辯* (Jiang jun shu chong juan, 1883), Harvard-Yenching Library, j. 4, 25a.

[110] Ma and Han, *Zhongguo Min Jian Zong Jiao Shi*, 652

[111] Li, *Bao Juan Lun Ji*, 299, 303.; Ma and Han, *Zhongguo Min Jian Zong Jiao Shi*, 648

[112] Wang Jianchuan, ed., "San Jiao Ying Jie Zhen Jing 三教應劫真經," in *Ming Qing Min Jian Zong Jiao Jing Juan Wen Xian Xu Bian 明清民間宗教卷文獻續編*, vol. 6 (Xin wen feng chu ban gong si, 2006).; Li, *Bao Juan Lun Ji*, 294-295.; Pu Wenqi, "San Jiao Ying Jie Zong Juan Tong Shu Zai Tan: Jian Yu Li Shiyu Xian Sheng Shang Quan '三教应劫总观通书'再探———兼与李世瑜先生商榷," *Qiu Suo*, no. 4 (2007): 52–54.

[113] Zhongguo zong jiao li shi wen xian ji cheng bian zuan wei yuan hui, ed., "Pu Ming Ru Lai Wu Wei Liao Yi Bao Juan 普明如來無為了義寶卷," in *Min Jian Bao Juan*, vol. 2, Zhongguo Zong Jiao Li Shi Wen Xian Ji Cheng (Huangshan shushe, 2005). 444; Wang, ed., "San Jiao Ying Jie Zhen Jing", 357-365. See also Ma and Han, *Zhongguo Min Jian Zong Jiao Shi*, 648-649; Naquin, *Millenarian Rebellion in China*, 11-12.; Li, *Bao Juan Lun Ji*, 299, 304-305, 312-313.

because they introduced new forms of agents, qi, and alignments of the stems and branches, they created alternative systems of authority against the state standards.[114]

Even as the government relaxed its control over the market, they increased their oversight towards orthodoxy. Because these movements persisted and continued to generate discontent, the government tried to regulate private almanacs through the control of these documents. These documents derived from popular religious traditions and precious scrolls. They carried religious authority and autonomy, but they offered an alternative theory of temporality and temporal order against the state. Although the government faced issues in military coordination regarding the suppression of these groups, the idea that the government needed to control this type of publication did not diminish.

Treaty Ports and Commercial Almanacs

Orthodoxy also transformed into questions of territoriality. When commercial printers followed state regulations, they initially had more leeway in their publication. This is evident from the state calendars that started to circulate in the nineteenth century (see Chapter 1). The commercial printers who specialized in government information, such as Ronglu tang and Rongjin tang, entered the calendar trade to support the distribution and use calendars as a stable income. Other private agencies also created new forms of calendars to sell to different audiences such as the unusual set of Daoguang-era calendars. In all of these cases, the printers generally labelled their calendars *Shixian shu*. This name meant that at a minimum, even if they were privately publishing the document, they recognized state authority. Although they changed the sizes of the pamphlets, and they adjusted the content for audience and geography, they generally maintained connections with the state calendar. There was even some flexibility allowed in terms of the names. Some of these calendars called themselves almanacs *tongshu* on the outer covering, but all of the internal content was based on a state calendar or at least a locally-adjusted form of that state calendar.

As a result, the state's permissiveness towards private publishing allowed new figures to enter almanac markets, even individuals who sponsored certain levels of non-conformity and

[114] The new era included two additional agents to the traditional five. Li, *Bao Juan Lun Ji*, 304. There were also 42 star constellations, 36 qi divisions, 96 jiazi combinations. Wang, ed., "San Jiao Ying Jie Zhen Jing," 365-366

dissent. The case of the Danzan Ravjaa (1803-1857) is especially illustrative.[115] This was an unsanctioned lineage outside the bounds of the Tibetan hierarchy and the recognized lines of reincarnation. Initially, the government wanted to suppress his lineage. One of the reasons why he was particularly noteworthy in the 1830s was because he was highly respected for his foresight. He practiced astrology and fate calculation, and he criticized religious leaders, acquiring a significant following among Mongols because of his efforts to use Mongolian to teach.[116]

Nevertheless, the Qing did not treat him like White Lotus societies, despite his threats to the religious establishment. He publicly disregarded religious leaders, but his astrological practices were based on imperial textbooks. His library did contain some special transmissions, which gave his practice some uniqueness, but many of his astrological works were related to semi-official sources like the *Jade Casket Manual*, i.e. the *Yuxia ji* 玉匣記.[117] This was a vernacular manual published in the eighteenth century that simplified many of the imperially-sanctioned practices for divination. This book was a type of almanac and overlapped with the *tongshu* genre, although it contained more material on talismanic healing. Regardless, the *Jade Casket Manual* recognized the authority of the imperial books on divination and astrology. The book had a wide circulation in popular culture.[118] This circulation was not exclusive to Chinese-language editions. Government printers in Beijing translated the work in Manchu and Mongolian, because it was also respected as an authority in Buddhist practices of time and fate.[119] Hence, it is these official

[115] For biographical details on the Danzan Ravjaa, see Hamid Sardar, "Noyon Khutuktu Danzan Ravjaa," in *The Treasury of Lives*, 2016, https://treasuryoflives.org/biographies/view/Danzanravjaa/13588.; "Danzin Rabjai," in *Encyclopedia of Mongolia and the Mongol Empire*, by Christopher Atwood (Greenwood Press, 2004), 130-132.; Uradyn Bulag et al., eds., "Danzan Ravjaa: The Fierce Drunken Lord of the Gobi," in *Proceedings of the Tenth Seminar of the IATS, 2003, Volume 9: The Mongolia-Tibet Interface Opening New Research Terrains in Inner Asia* (Brill, 2007), 257-294.; Michael Kohn, *Lama of the Gobi: How Mongolia's Mystic Monk Spread Tibetan Buddhism in the World's Harshest Desert* (Blacksmith Books, 2010).

[116] "Danzin Rabjai," in *Encyclopedia of Mongolia and the Mongol Empire*, by Christopher Atwood (Greenwood Press, 2004), 131.

[117] This book was cited as a source in a case in Guizhou, but the person was tried as a physician manipulating the population rather than under sedition. The state did not view this book as a threat to order like other almanacs. Ying Zhang, "Household Healing: Rituals, Recipes, and Morals in Late Imperial China" (Phd Dissertation, Johns Hopkins University, 2017), 52-53.

[118] For an analysis on the use of this book in household practices and its connection to ritual healing, see Zhang, "Household Healing", 50-55.

[119] See, for example, L-286, John R. Krueger, "Catalogue of the Laufer Mongolian Collections in Chicago," *Journal of the American Oriental Society* 86, no. 2 (1966): 164.; Walther Hessig, *Catalogue of Mongol Books, Manuscripts and Xylographs* (The Royal Library, 1971), 166-176.; Xu Xun, "Mandchou 218 Ioi Hiya Gi Yu Xia Ji 玉匣記," n.d., Mandchou 218, Bibliotheque Nationale de France, Département des Manuscrits.; Xu Xun, "Mandchou 219 Ioi Hia Gi Bithe Yu Xia Ji 玉匣記," n.d., Mandchou 219, Bibliotheque Nationale de France, Département des Manuscrits. For more on Mongolian perspectives towards Chinese divination, see Alice Sarkozi, "A Mongolian

editions and translations that were used by the Danzan Ravjaa.[120] The state then allowed this type of dissent and new calendar making, so long as the leaders recognized the state's political authority.

Western merchants and missionaries similarly benefited from the relaxation of the rules. Church calendars in Chinese combined ritual days and Sundays from the Gregorian calendar against the standard Chinese lunar calendar. These documents had established histories in Chinese Christian communities; and these documents had the opportunity to circulate once the government relaxed its suppression of native Chinese communities.[121] Protestants and foreign merchants also sponsored the production of mixed calendars in Guangzhou and Southeast Asia. Periodicals in the Straits Settlement started to publish combined calendars from the 1820s.[122]

There were also examples in Guangzhou. The *Eastern and Western Monthly Magazine* 東西洋考每月統記傳 (1833-1837), for instance, followed the imperial calendar, and the authors included an ongoing series that synchronized Chinese and Western historical chronologies and dates.[123] In 1838, the Society for the Diffusion of Knowledge and Learning in China was especially interested in the idea of using almanacs as a format to introduce scientific and technical learning. In their fourth annual review, they published a report on reading. They noted in their report that the imperial calendars and the almanacs were among the most popular genres read by the

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Manual of Divination by Means of Characteristics of the Land," in *Tractata Altaica: Denis Sinor, Sexagenario Optime de Rebus Altaicis Merito Dedicata*, ed. Walther Heissig (Harrassowitz, 1976).; Ondřej Srba, "Frame Narratives Concerning the Chinese Origin of Divination and Geomancy in Mongolian Manuscript Texts," *Acta Orientalia Academiae Scientiarum Hungaricae* 74, no. 3 (2021): 431–82.

[120] For more on this library, see Uradyn Bulag et al., eds., "Danzan Ravjaa: The Fierce Drunken Lord of the Gobi," in *Proceedings of the Tenth Seminar of the IATS, 2003, Volume 9: The Mongolia-Tibet Interface Opening New Research Terrains in Inner Asia* (Brill, 2007), 258.; Caroline Humphrey, "The Treasures of Danzan Ravjaa (EAP031)," *Endangered Archives Programme*, 2005, https://doi.org/10.15130/EAP031.

[121] The government did not change its view about foreign missionaries before the 1840s. Missionaries were banned from entering China until the time of the Treaty Ports. So there were still periodic campaigns when local officials discovered foreign missionaries in the interior. Lars P. Laamann, *Christian Heretics in Late Imperial China: Christian Inculturation and State Control, 1720-1850* (Routledge, 2006), 70-81.; Eugenio Menegon, "The 'Teachings of the Lord of Heaven' in Fujian: Between Two Worlds and Two Times," in *Time, Temporality, and Imperial Transition: East Asia from Ming to Qing*, ed. Lynn A. Struve (University of Hawaii Press, 2005), 195-199.

[122] Cecil K. Byrd, *Early Printing in the Straits Settlements, 1806-1858* (Singapore National Library, 1970), 23.

[123] The system used the upper and lower registers to compare chronologies. See Karl Gützlaff, *Dong Xi Yang Kao Mei Yue Tong Ji Zhuan 東西洋考每月統記傳*, vol. 1 (Guangzhou, 1833), Harvard-Yenching Library., 4a ff. For the significance of this work in the history of Chinese periodicals, see Xiantao Zhang, *The Origins of the Modern Chinese Press: The Influence of the Protestant Missionary Press in Late Qing China* (Routledge, 2007), 39-41.; Michael C. Lazich, "The Diffusion of Useful Knowledge in China: The Canton Era Information Strategy," in *Mapping Meanings: The Field of New Learning in Late Qing China*, ed. Michael Lackner and Natascha Vittinghoff (Brill, 2004).

population, and so they suggested working in this model as a format for introducing new types of information within a local genre.[124]

John Robert Morrison (1814-1843), John Slade (1790-1854), and Samuel Wells Williams (1812-1884) were involved in some of these efforts except they targeted English readers.[125] Working with the Canton Register Press, they published a directory and almanac for merchants. The project began in 1832, and then it was published on nearly an annual basis for several years.[126] The book used the Gregorian calendar as the organizing standard. But the book provided translations and equivalents for days matched to the Chinese calendar. The work also combined festivals and religious days to provide notes for the user on holidays or other special events.[127]

Works of these types exploded following the negotiation of the treaty ports, and they became even more direct in their application of multiple calendars. For instance, missionaries in Hong Kong, Canton, Shanghai, and Fuzhou all produced almanacs that they called "Chinese and Western" almanacs (see Table 2-2).[128] These pamphlets were annual books that included a variety of useful information, including maps, gazetteers, and news. They frequently included translations of missionary texts as well as translations of scientific and industrial information. In terms of almanacs, they were most remarkable for publishing coordinated calendars. The front covers of these books all created equivalent dates for imperial Chinese calendars and Gregorian dates. They also included special tables for calendar coordination. The first pages of Dyer Ball's Hong Kong almanacs organized Sundays by listing each Sunday's corresponding Chinese lunar and Gregorian

[124] Turner, "Fourth Annual Report for the Society of the Diffusion of Useful Knowledge in China." See also Songchuan Chen, "An Information War Waged by Merchants and Missionaries at Canton: The Society for the Diffusion of Useful Knowledge in China, 1834–1839," *Modern Asian Studies* 46, no. 6 (2011): 1715-1716.
[125] Biographical details are included in Alexander Wylie, *Memorials of Protestant Missionaries to the Chinese: Giving a List of Their Publications, and Obituary Notices of the Deceased* (American Presbyterian Mission Press, 1867), 10-11, 76-79.; Frank H. H. King and Prescott Clarke, *A Research Guide to China-Coast Newspapers, 1822–1911* (Harvard University Press, 1965), 152.
[126] Alexander Wylie, *Memorials of Protestant Missionaries to the Chinese: Giving a List of Their Publications, and Obituary Notices of the Deceased* (American Presbyterian Mission Press, 1867), 79.
[127] John Slade, *The Anglo-Chinese Kalendar Yinghua Lishu 英華曆書 for the Year of the Christian Era 1836* (Canton Register Press, 1836).
[128] The *Shanghae Serial* or the *Liuhe congtan* 六合叢談 was another publication that also produced special joint calendars. See Joseph Edkins, *Liu He Cong Tan 六合叢談* (Mo hai shu guan, 1857), 990082549990203941, Harvard-Yenching Library, 1b.

dates.[129] Justus Doolittle by contrast published a calendar that included every day of the year with its corresponding Chinese and Gregorian dates which also highlighted Sundays.[130]

Table 2-2: Treaty-port almanacs. These almanacs circulated religious, scientific, and technical knowledge. But they also promoted the use of the Gregorian calendar against the Chinese calendar. Sources: Entries compiled from records and catalogues of Harvard-Yenching Library, Oxford University Bodleian Library, Cambridge University, University of London School of Oriental and African Studies, University of California Berkeley.

Title	Creator	Location	Date	Note
西洋中華通書	Doolittle, Justus, 1824-1880	Fuzhou	1858	This is the only year of publication for this work
華英和合通書 華番和合通書 和合通書 日月刻度通書 華番和合通書 唐番和合通書	Ball, Dyer, 1796-1866 French, John Booth, 1822-1859 Vrooman, Daniel, 1818-1895	Hong Kong, Canton, Macau	1843-1864	This work went by several names over the years, and it shifted between different proprietors.
華洋和合通書 中西通書	Edkins, Joseph, 1823-1905 Wylie, Alexander, 1815-1887	Shanghai, Tianjin, Beijing	1852-1866	Edkins started this publication in 1852 to 1858. Then Wylie managed it. Because of their relocations, the publication followed them. With the exception of 1862, it was published annually.
平安通書	McCartee, Divie Bethune, 1820-1900	Ningbo	1850-1853	The almanac is currently held in the Bodleian.

In Ningbo, Divie McCartee published a particularly significant almanac. This almanac was similar to the other missionary almanacs insofar as it combined translations with useful information. McCartee included special sheets of new astronomy and popular science, and he even produced comparative lists of numbers to teach how to read a clock.[131] McCartee also generated comparative calendars. The middle of the almanac contained lists of dates that combined Chinese lunar calendar dates with Gregorian calendar dates.[132] The content and lists had a wide readership.

[129] Dyer Ball, *Hua Fan He He Tong Shu 華番和合通書* (Hong Kong, 1847), 990094361560203941, Harvard-Yenching Library.
[130] Justus Doolittle, *Xi Yang Zhonghua Tong Shu 西洋中華通書* (Nan tang bao fu shan, 1858), 990083166000203941, Harvard-Yenching Library.
[131] Divie McCartee, *Sinica 1310 Pingan Tongshu* (Hua hua sheng jing shu fang, 1850), Sinica 1310, Bodleian Library. Fu gu luo ma zi shu mu he shi chen zhong biao yin shi
[132] McCartee, *Ping an Tong Shu*. An xi ri qi, 1a-7b

Wei Yuan 魏源 (1794-1857) added most of the content in his third edition of the *Haiguo tuzhi* 海國圖志 (1852 edition).[133]

In each of these cases, the authors adopted the term "almanac" *tongshu* rather than calling the calendars *Shixian shu* to avoid the official regulations; but because these books were published in the treaty ports, the authors had access to legal structures that protected them from other forms of imperial oversight. These protections included the extraterritorial rights that allowed foreign individuals in China to be tried under their own legal systems and mixed courts, an institutional arrangement that proved especially beneficial to missionaries and their proselytization.[134] These protections inspired many critical views among local Chinese dissenters as well. For instance, newspapers in Hong Kong and Shanghai published government documents, but also published news and opinion that challenged censorship rules.[135] Nationalist groups also used treaty ports for protection. By 1904, these protections had even extended to radicals like Zou Rong 鄒容 (1885-1905) who had printed statements labeled as treason, but who were able to get limited prison sentences instead of the death penalty because of their publication in Shanghai.[136]

Although the case of Zou Rong was a major turning point in debates over legal authority and treaty ports, private calendars and almanacs demonstrate that these conflicts over information and state authority had already faced earlier decisions that favored protection for heterodox printing.[137] Even though calendar printing was allowed to remove the passages related to beheading, local officials renewed the efforts to make the state information clear with public edicts.

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[133] Wei Yuan, *Hai Guo Tu Zhi 海國圖志* (Jinggudao shu, 1876), j. 100.

[134] For the rise of extraterritoriality and mixed courts, see Pär Kristoffer Cassel, *Grounds of Judgment: Extraterritoriality and Imperial Power in Nineteenth-Century China and Japan* (Oxford University Press, 2011).; For the impact on missionaries, see Paul A. Cohen, *China and Christianity: The Missionary Movement and the Growth of Chinese Antiforeignism, 1860-1870* (Harvard University Press, 1963), 270.

[135] Paul A. Cohen, *Between Tradition and Modernity: Wang T'ao and Reform in Late Ch'ing China* (Harvard University Press, 1974), 75-81.; Joan Judge, *Print and Politics: 'Shibao' and the Culture of Reform in Late Qing China* (Stanford University Press, 1997), 18.; Rudolf Wagner, "The Shenbao in Crisis: The International Environment and the Conflict Between Guo Songtao and the Shenbao," *Late Imperial China* 20, no. 1 (1999): 107–43.; Emily Mokros, *The Peking Gazette in Late Imperial China: State News and Political Authority* (University of Washington Press, 2021), 140-166.

[136] John Lust, "The Su-Pao Case: An Episode in the Early Chinese Nationalist Movement," *Bulletin of the School of Oriental and African Studies* 27, no. 2 (1964): 408–29.; Cassel, *Grounds of Judgment*, 172-174.; Stefan Kroll, "Public-Private Colonialism: Extraterritoriality in the Shanghai International Settlement," in *International Law in the Long Nineteenth Century (1776-1914): From the Public Law of Europe to Global International Law?*, ed. Inge Van Hulle and Randall C. H. Lesaffer (Brill, 2019), 151-154.

[137] During the Taiping Rebellion, the government also created a stricter management over information flows. Emily Mokros, *The Peking Gazette in Late Imperial China: State News and Political Authority* (University of Washington Press, 2021), 142.

These edicts frequently occurred during the process of distribution, and local officials tried to reassert the fact that private printing still required government seals. Individuals were supposed to go to the government office and receive some authentication, and they were supposed to follow the orthodox standards based on the imperial textbooks.[138]

Since local officials nearby treaty ports tried to reassert control over these printers, several cases appeared in Shanghai in which the government punished counterfeiting. For example, in 1873, two individuals were arrested for counterfeiting calendars. They were accused of using fake seals to authenticate the calendars. The government confiscated their woodblocks and calendars. But the reports stated that the government never actually found the seal that carvers were supposed to be using to create the counterfeits.[139] In another case from 1886, the government arrested a man named Jin Debao 金德寶 who was also accused of using faked seals to sell calendars. But when the government tried to investigate, they were unable to get the proper witnesses and collect the actual seal.[140] In another case from 1881, the government published edicts against the selling of the *Xiangji tongshu*. Although this book was legal to produce, they realized that people in the settlement were using it as an authority for designing alternative calendars that did not align with the state standards.[141]

The Shanghai settlement was particularly challenging to control because it contained a new mobile population of sojourners. Immigrants had flocked to Shanghai following the Small Swords and Taiping Rebellions. There were thousands of newcomers. Although some immigrants returned to their homes after the Rebellion for a short reprieve, the population continued to grow rapidly. The lowest classes in this group known as vagabonds (*youmin* 游民) were often labeled as troublemakers.[142] This included itinerant woodblock carvers; for these carvers were able to produce fake seals to make a quick profit with calendars. The complex relationships in the treaty port made it easier for these figures to dodge the imperial law.[143]

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[138] For publications of such edicts, see Shenbao 1872.19.9, 2-3; 1877.11.22, 3; 1881.1.16, 2; 1882.11.29, 2; 1884.12.5, 3; 1890.10.11, 2; 1894.11.14, 4; 1894.11.26, 3; 1895.12.14, 8; 1896.11.25, 3

[139] Shenbao, 1873.1.25, 6

[140] Shenbao, 1886.11.21, 3; Shenbao, 1886.11.23, 3; Shenbao, 1886.11.25, 3

[141] Shenbao, 1881.1.16

[142] Bryna Goodman, *Native Place, City, and Nation: Regional Networks and Identities in Shanghai, 1853-1937* (University of California Press, 1995), 62-68. For comparisons with other views on vagabonds, see Philip A. Kuhn, *Soulstealers: The Chinese Sorcery Scare of 1768* (Harvard University Press, 1990), 41-47.; William T. Rowe, *Hankow: Conflict and Community in a Chinese City, 1796-1895* (Stanford University Press, 1989), 218-219.

[143] Shenbao, 1877.11.22, 3; Shenbao, 1886.11.23, 3

Territory and sovereignty also came through these debates. For example, when Huang Chengyi 黃承乙 (1844-1924) was appointed to the Shanghai Mixed Court, he published a new edict about calendar counterfeiting in Shanghai and blamed the city for not taking the problem more seriously.[144] While there are few comments about his calendar edict, Huang was a conservative and was viewed by the British as not having enough experience in law. His tenure became a flashpoint in debates over control and legal interpretation in the court system, eventually coming to physical blows because of their different perspectives about authority and interpretation.[145]

Almanac printing mattered in these cases because it was about state legitimacy. This fact has tended to overshadow the significance of 1816. By the Jiaqing reign, the government had come to a general accommodation with private printing. These individuals were allowed to work with the government if they maintained state orthodoxy. Treaty ports created new conditions for these concerns about heterodoxy. The issue was no longer only whether an almanac followed imperial standards, but also which legal authority had the power to regulate its production and circulation. This was another aspect of orthodoxy, now reframed through sovereignty and territorial jurisdiction.

2.2 Almanac Makers of South China

Commercial printing changed in the nineteenth century. These printers had permission to circulate their almanacs as the government refocused on orthodoxy rather than print control. Private merchants were able to sell calendars in a wider market. But what did the legal market look like? How did almanac makers create their products under these conditions? Because commercial printers were involved in the popular market and left few written or documentary records, we have limited access to commercial printers through traditional archival sources, such as local gazetteers, collected writings, or even memorials. This section therefore uses the material texts of calendars and almanacs to reconstruct how almanac makers organized and managed their operations.

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[144] Shenbao, 1884.12.5, 3

[145] Motono Eiichi, "H. A. Giles versus Huang Chengyi : Sino-British Conflict over the Mixed Court 1884-1885," *East Asian History* 12 (1996): 135–57.; For additional context on the court, see Cassel, *Grounds of Judgment*, 63-84.; Pär Kristoffer Cassel, "Mixed Court of the Shanghai International Settlement," in *Max Planck Encyclopedias of International Law* (Oxford University Press, 2023), https://opil.ouplaw.com/display/10.1093/law-mpeipro/e3151.013.3151/law-mpeipro-e3151.

Almanac makers had relationships with the government which helped secure their reputation. These groups also harnessed family networks and collaborations with distributors and bookshops to circulate their private almanacs and calendars widely. Moreover, almanac makers used new design strategies and page layouts to create innovative methods to facilitate the reading process of time information. Because almanac makers treated information as a type of flexible input, they pioneered some of the earliest modes of information units that were recycled and which came to dominate later popular readings experiences. The material texts offer a guide for understanding what almanac making looked like on the ground and how this tradition both reflected the legal permissions and challenges with orthodoxy.

Although almanacs were produced throughout the entire Qing territory, this section focuses specifically on South China for the unique survival of almanacs from this region. Calendars and almanacs were important items for everyday use. But they were not high-status. Book collectors used calendars, just as everyone else, but they rarely treated almanacs in the same categories as other rare books or imprints.[146] Almanacs like gazettes and other ephemera can be found in collections and libraries, but they require some sleuthing to find them in catalogues and lists.[147] Foreign merchants and missionaries frequently collected these books because they were affordable and accessible. Some of the earliest books brought to Europe were almanacs from South China. This remained important even into the late nineteenth century as missionaries continued to collect and read these books as a source to learn about everyday life and to organize and schedule events in accordance with traditional schedules.[148] As a result, out of the hundreds of almanacs which

[146] Xie Zhaozhe was one such scholar who wrote in opposition to cheap books. Huang Zongxi introduced library collecting criteria that distinguished between common books that were widely available and rare works. Lucille Chia, *Printing for Profit: The Commercial Publishers of Jianyang, Fujian (11th–17th Centuries)* (Harvard University Asia Center, 2003), 185-186.; Duncan Campbell, "The Moral Status of the Book: Huang Zongxi in the Private Libraries of Late Imperial China," *East Asian History* 32/33 (2007 2006): 1–24.; Fan Wang, "Agency in the Margins: Readers and Collectors in Late Imperial China" (Phd Dissertation, University of Massachusetts Amherst, 2020), 55-56. For more on book discrimination and evaluation, see Congtian Sun and Achilles Fang, "Bookman's Manual," *Harvard Journal of Asiatic Studies* 14, no. 1/2 (1951): 222-228.; Dehui Ye, "Bookman's Decalogue," trans. Achilles Fang, *Harvard Journal of Asiatic Studies* 13, no. 1/2 (1950): 138-141.

[147] James Hayes, "Specialists and Written Materials in the Village World," in *Popular Culture in Late Imperial China*, ed. David Johnson et al. (University of California Press, 1985), 75-111.; Patrick H. Hase, "Village Scholars in the Traditional New Territories and Their Book Collections," *Journal of the Royal Asiatic Society Hong Kong Branch* 63 (2023): 179–225.; Ronald Suleski, *Daily Life for the Common People of China, 1850 to 1950* (Brill, 2018), 11-12.; Kai-wing Chow, "Experience of Print in Everyday Life in Imperial China," *Studies on Asia* 1, no. 1 (2016): 9–16.; Emily Mokros, "Chinese Gazettes on the Margins of Book History: Movable Type, Wax Stereotypes, and Vernacular Techniques in Late Imperial China," *Book History* 26, no. 1 (2023): 164–167.

[148] Lister, "Chinese Almanacs."; Hermann Fritsche, "On the Chinese Calendar," *China Review*, 1882, 326-334.; Parker, "The Chinese Almanac."

have survived, most come from the region of South China, and this region therefore provides one of the longest records of almanac printing, allowing us to more closely investigate how makers managed their relationship to officials and focused on profit.

In part one, I explore the legal context for how regulations impacted printing. In part two, I use the material texts of South China almanacs to examine how makers created their own calendars, competed in local markets, and organized their trade. There were three different types of almanac makers, and they had different emphasizes and connections to the state printing efforts. They created multiple innovations to facilitate access to time information. They created new designs and layouts that reorganized information. These approaches towards information had consequences that allowed almanacs to become media platforms for popular readers.

Social Background of Almanac Makers

The South China book market centered on Guangzhou and the province of Guangdong. But it also extended along the coast to Fujian province, into the interior through Guangxi, and to other diaspora communities in the Pearl Delta and Southeast Asia.[149] Accordingly, there were three different forms of almanac makers that distributed and sold almanacs in this region: 1) lineage almanac makers; 2) commercial printers; and 3) individuals compiling calendars sold to printers.

Family Lineage

The compilation of almanacs was a special form of knowledge. It was controlled by family lineages similar to other forms of specialized trade, such as lineage astronomers or medical lineages.[150] Much like how these lineages transmitted secret knowledge which boosted their reputations, almanac makers transmitted specialized learning about fate calculation and astronomical knowledge which gave them expertise. These almanac makers transmitted their teaching through clan-based institutions. These teachings were separate from printing. Although many families also

[149] Zhang Xiumin, *Zhongguo Yin Shua Shi 中國印刷史* (Shanghai ren min chu ban she, 1989), 555-558.; Cynthia J. Brokaw, *Commerce in Culture: The Sibao Book Trade in the Qing and Republican Periods* (Harvard University Asia Center, 2007), 194.; Florence Bretelle-Establet, "Human Mobility and Books: Modes of Circulation of Medical Ideas and Doctrines in the Far South of China 18th and 19th Centuries," in *Individual Itineraries and the Spatial Dynamics of Knowledge: Science, Technology and Medicine in China, 17th-20th Centuries*, ed. Catherine Jami (Institut des Hautes-études chinoises, 2017).

[150] Volker Scheid, *Currents of Tradition in Chinese Medicine, 1626-2006* (Eastland Press, 2007). ; Chang, *The Chinese Astronomical Bureau, 1620-1850*.

created printing businesses and distribution partnerships too, these families could also sell their expertise in other ways beyond simply making the actual almanacs. In this sense, family lineages were able to use both their source of knowledge along with organized forms of printing to create their business networks. Based on the popularity of surviving almanacs, there were three main family lines that controlled almanac making in South China: Hong, Luo, and Cai families.

Hong: One of the best documented families involved in almanac making in South China is the Hong 洪 lineage.[151] This family originally came from Tong'an 同安 county in Fujian province, not far from Quanzhou and Xiamen. But their networks extended beyond Fujian into Taiwan, Guangdong, and Hong Kong. They published an almanac which was called the Jicheng tang 繼成堂 almanac. The name originally referred to the site for their services in day selection, but the name accompanied the spread of the business along the coast. There were already multiple buildings shared by brothers and cousins in the early nineteenth century, and the business continued to spread with branch divisions and new locations even into the present.[152]

The founder was named Hong Chaohe 洪潮和 (eighteenth century). He was considered an expert in astrology (*xingxue* 星學), whose teachings were widely respected. According to a preface later added to the almanac, the writer, a *jinshi* scholar named Wu Huancai 吳煥彩 (1725-1806), praised Hong's expertise. Wu mentioned meeting Hong while visiting Quanzhou. He said that Hong had gained his knowledge in Beijing, where he purchased the imperial textbooks on astrology and astronomy. He brought those books back to Fujian and relied on them for his business.[153] Hong's almanac continued with his sons. Hong was later added to the provincial gazetteer, which remarked that the almanac circulated widely in southern China and even to diaspora communities in Southeast Asia.[154]

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[151] Chinese scholars have tried to collect documents and oral histories from this family. Huang, "Tong Shu Zhong Guo Chuan Tong Tian Wen Yu She Hui de Jiao Rong," 170-180.; Chen Jinguo, "Min Jian Tong Shu de Liu Xing Yu Feng Shui Shu de Min Su Hua 民間通書的流行與風水術的民俗化," *Taiwan Zongjiao Yanjiu Tongxun* 10, no. 4 (2002): 195–230.

[152] The front cover of the almanacs includes the location of one of the branches: within the city walls of Quanzhou between Qingting street and Daokou road. Jichengtang, *Qing Tongzhi San Nian Jia Zi Li Shu 清同治三年甲子曆書* (Jichengtang, 1864), 990090252110203941, Harvard-Yenching Library.

[153] Jichengtang, *Qing Tongzhi San Nian Jia Zi Li Shu 清同治三年甲子曆書* (Jichengtang, 1864), 990090252110203941, Harvard-Yenching Library, preface, 1a-1b.

[154] *Chong Zuan Fujian Tong Zhi 重纂福建通志* (1871). j. 247, 13a

More than just the imperial textbooks, the family provided multiple sets of evidence that they worked alongside the government and that they represented an authenticated practice. On the front pages of the almanac, they included an edict from the Yongzheng period as a part of their claims to have long received permission to create a private calendar.[155] They also made sure that their calendars included the dates and selected times for the seasonal divisions and months in accordance with the imperial calendar.[156] When a rival agency tried to pirate their almanac during the Daoguang period, the family added warnings and seals to their almanacs (see Figure 2-3, Figure 2-4), and they filed petitions with the government to protect their agency as the authentic Jichengtang.[157]

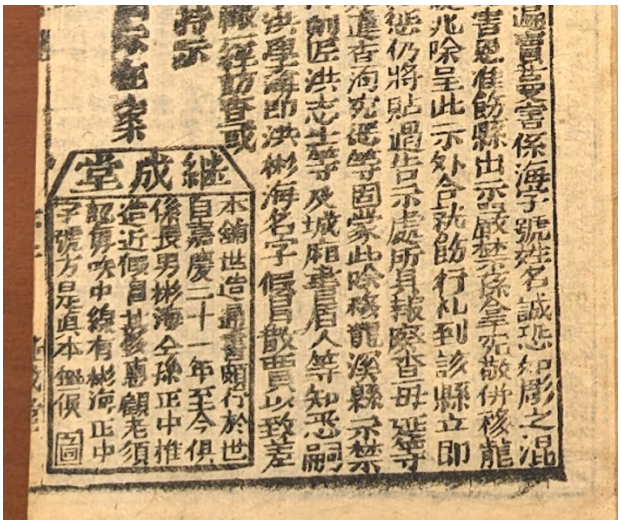

Figure 2-3: Jichengtang Advertisement. Close-up on the advertisement and statement by the family declaring that this was an official edition. This was a part of the conclusion of a document added to reaffirm their originality in the face of copyright cases. Source: Author image, Harvard-Yenching Library.

[155] Jichengtang, *Qing Tongzhi San Nian Jia Zi Li Shu 清同治三年甲子曆書* (Jichengtang, 1864), 990090252110203941, Harvard-Yenching Library, 1a.; Huang, "Tong Shu Zhong Guo Chuan Tong Tian Wen Yu She Hui de Jiao Rong," 183.
[156] Huang, "Tong Shu Zhong Guo Chuan Tong Tian Wen Yu She Hui de Jiao Rong," 179.
[157] Richard Smith, "The Legacy of Daybooks in Late Imperial and Modern China," in *Books of Fate and Popular Culture in Early China: The Daybook Manuscripts of the Warring States, Qin, and Han*, ed. Donald Harper and Marc Kalinowski (Brill, 2017), 354, figure 9.5.; Huang, "Tong Shu Zhong Guo Chuan Tong Tian Wen Yu She Hui de Jiao Rong," 175.

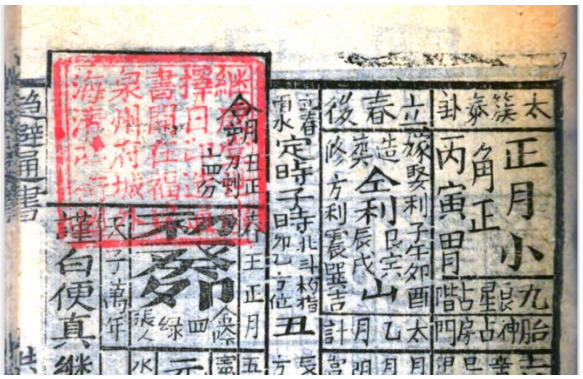

Figure 2-4: Jichengtang Seal. This is the seal for the almanac, added to the first pages of the calendar component. The seal adds additional layers of authenticity and plays on the seals used to authenticate calendars. Source: Harvard-Yenching Library.

Yet the family distinguished itself with its own interpretations and uniqueness. They continued to calculate some features of the annual spirits and influences that were discarded with the *Xieji bianfang shu*.[158] The family sold instruments and services, such as clepsydrae and incense burners, in addition to the almanacs.[159] On some of their almanacs, they also published that they had a secret formula for *wanying shenqu* 萬應神麯, a remedy associated with Quanzhou.[160]

The family distributed the almanac widely. Starting from 1816, the family included detailed lists of "disciples" or *menren* 門人 (see Figure 2-5). These lists which included more than 60 different names were primarily located in Fujian province, but they also reported people with registrations in Zhejiang and Taiwan. The term *menren* typically referred to a student-teacher relationship. Huang Yi-Long, however, suggests that these "disciples" were not students in the sense of transmission, but they were regional partners who distributed and sold the almanac as a part of the wider business circuit.[161] Based on oral histories he conducted with the family, his informants explained that the techniques for compiling the almanac remained in-house, but the

[158] Huang, "Tong Shu Zhong Guo Chuan Tong Tian Wen Yu She Hui de Jiao Rong," 171-173.
[159] Jichengtang, *Qing Tongzhi San Nian Jia Zi Li Shu 清同治三年甲子曆書* (Jichengtang, 1864), 990090252110203941, Harvard-Yenching Library, front cover.; See also Huang, "Tong Shu Zhong Guo Chuan Tong Tian Wen Yu She Hui de Jiao Rong," 174-175
[160] This was a medical formula attributed to a local doctor from Quanzhou named Wu Yifei 吳亦飛 (fl. 1733-1757), and it was said to be able to heal a variety of common ailments like Cold Damage disorders and digestion. Yao Heng, *Han Xiu Cao Tan Bi Ji 寒秀草堂筆記*, Cong Shu Ji Cheng Chu Bian 367 (1887; Shang wu yin shu guan, 1937), j. 4, 101.; Richard Smith, "The Legacy of Daybooks in Late Imperial and Modern China," in *Books of Fate and Popular Culture in Early China: The Daybook Manuscripts of the Warring States, Qin, and Han*, ed. Donald Harper and Marc Kalinowski (Brill, 2017), 354, figure 9.5; Huang, "Tong Shu Zhong Guo Chuan Tong Tian Wen Yu She Hui de Jiao Rong," 174.
[161] Huang, "Tong Shu Zhong Guo Chuan Tong Tian Wen Yu She Hui de Jiao Rong," 173-174.

actual printing was done through hired labor. They outsourced the printing to a village where about 60 to 70 people were involved in the block carving and printing. The orders were generally completed by the eighth to ninth month, when the family worked with their regional partners to distribute it to bookshops in advance of the upcoming new year.[162] In other words, the family almost always had their almanacs prepared before the imperial calendar and ready for sale.



Figure 2-5: List of Jicheng tang Disciples. This is the printed list of names attached to the Jicheng tang. Source: Author image, Harvard-Yenching Library

Luo: Another important almanac lineage in South China was the Luo 羅 family. The Luo family were of Hakka descent and lived in several villages in the vicinity of Xingning 興寧, in the northeast corner of Guangdong province. Similar to the Hong almanac, the Luo lineage also distributed their almanac across a large territory. Already by 1812 and 1824, according to the front cover of their almanacs, the family had established branch houses in Xingning and in Tingzhou 汀州 in neighboring Fujian.[163] All of the almanacs in this tradition are related with the term Luo to connect them to the family lineage. But over time, with the growth of the business and the participation of multiple family lines in the compilation process, new halls emerged to accompany

[162] Huang, "Tong Shu Zhong Guo Chuan Tong Tian Wen Yu She Hui de Jiao Rong," 180.
[163] Luo Chuanlie, *Luo Chuanlie Tong Shu 羅傳烈通書* (Chongdao tang, 1824), RM c.41.t.8(11), School of Oriental and African Studies, Morrison collection.; Liu Zhaorui and Zhong Linchun, "Tong Shu Luo Yu Luo Jia Tong Shu 通書羅與羅家通書," *Wen Hua Yi Chan*, no. 4 (2012): 121, figure.

the publications. Hence, on the front page of a Republican-era version of the almanac, there were fifteen different hall names that were associated with it.[164]

According to family lore, the founder of the Luo almanac was named Luo Qinghui 羅慶輝 (1671-1743). Sources agree that he was an itinerant merchant, but there are conflicting reports as to how he learned astronomy and started to produce the almanac. Some stories say that he was literate in Classical Chinese and purchased the imperial textbooks while he was living in Beijing, and he then learned how to conduct astronomy from his own study. Other sources claim that he had help and entered the Beijing Astronomical Bureau. While both stories are suspect, this kind of mythology about the Astronomical Bureau carried an element of gravitas about the almanacs, connecting the family's techniques and training with imperial institutions.[165]

Much like the Hong family, the Luo almanacs claimed to be officially sanctioned. The opening page of the almanac included the edict from the Yongzheng emperor on the usefulness of almanacs.[166] While this edict did not guarantee the right to private publishing, as discussed in part one, the almanac makers treated it as a kind of recognition of their almanacs. Besides this, the family attributed their knowledge to learning from the imperial sources. In a preface dated to 1771 (Qianlong 36) that they attached to one of their early almanacs, they discussed how they used the imperial mathematics sources as well as the astronomical and astrological textbooks in the compilation process.[167] Luo Chuanlie also explained that he particularly had studied Western methods as a part of his learning.[168] Accordingly, the family strongly defended their almanac as an orthodox almanac that respected imperial calendars but supplemented it with the training that was required of interpretative works like almanacs.

The Luo family provided supplemental services to the almanac. They provided day selection services with expertise in the *qimen dunjia* 奇門遁甲 methods, a set of specialty forms of fate calculation that were considered especially esoteric and challenging.[169] They likely had

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[164] Liu and Zhong, "Tong Shu Luo Yu Luo Jia Tong Shu," 122.
[165] One account of the family comes from the genealogy collected in the Republican period. Luo Xianglin, ed., *Ke Jia Shi Liao Hui Pian 客家史料匯篇*, vol. 1 (Zhongguo xue she, 1992), 164-167.; Liu and Zhong, "Tong Shu Luo Yu Luo Jia Tong Shu," 116-117.
[166] Luo Chuanlie, *Chong Dao Tong Luo Chuanlie Tong Shu 崇道堂羅傳烈通書* (Chongdao tang, 1831), Libri sin. 707-4, Staatsbibliothek zu Berlin, 1a.
[167] Luo, *Chong Dao Tong Luo Chuanlie Tong Shu*, Preface, 1a-2b.
[168] Luo, *Chong Dao Tong Luo Chuanlie Tong Shu*, Preface, 2a.
[169] Luo, *Chong Dao Tong Luo Chuanlie Tong Shu*, Preface, 2b.; Ho Peng Yoke, *Chinese Mathematical Astrology: Reaching Out To the Stars* (Routledge, 2003), 83-112.

even more significance in geomancy and fengshui.[170] They provided consultation, and the family created and sold instruments. On the front covers of their almanacs, they advertised clepsydrae and fixed-time incense sticks which were based on the models from the astronomical bureau.[171] In addition to time instruments, the family created geomantic compasses. Geomantic compasses from Xingning were among the three most important sites for compass manufacturing in late imperial China.[172]

The Luo almanac spread through several networks. They held internal examinations to evaluate learners and determine which family members would be eligible to receive more sophisticated instruction in the almanac compiling.[173] Family members who were not involved in calculations contributed to block carving and printing, because unlike the Hong lineage, the Luo clan distributed the printing among the various halls and branches of the lineage.[174] According to later sources, for family that were not involved in printing or compiling, they participated in the traveling business which distributed the orders to bookshops and markets. This almanac had a wide reputation and was available in Guangdong, Guangxi, Fujian, Jiangxi, Sichuan, Hunan, Hubei, and Henan.[175]

Cai: Besides the Hong and Luo lineages, the third most important almanac making family, albeit somewhat late, was the Cai 蔡 lineage. The Cai family originated from Shunde 順德 in Guangdong province, but they moved to Guangzhou and soon spread to Hong Kong. The family almanac represents one of the last ongoing almanacs from the imperial period, for the almanac only started around 1890. Notwithstanding its late start, the almanac quickly acquired a popular reputation and become a leading lineage in regional almanac making.[176]

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[170] The family may have also been involved in popular medical traditions. In her study of the Sibao book networks, Cynthia Brokaw notes that the Chongde tang published several medical handbooks in different disciplines. The Chongde tang was one of the names used by the Luo family in its print network. Brokaw, *Commerce in Culture*. 445-446

[171] Luo, *Chong Dao Tong Luo Chuanlie Tong Shu*, Preface, front cover.

[172] Wang Zhenduo, "Si Nan Zhi Nan Zhen Yu Luo Jing Pan: Zhongguo Gu Dai You Guan Jing Ci Xue Zhi Shi Zhi Fa Xian Ji Fa Ming Xia 司南指南針與羅經盤: 中國古代有關靜磁學知識之發現及發明 下," *Zhongguo Kaogu Xuebao*, 1951, 166.; Liu and Zhong, "Tong Shu Luo Yu Luo Jia Tong Shu," 116.

[173] Liu and Zhong, "Tong Shu Luo Yu Luo Jia Tong Shu," 122.

[174] Liu and Zhong, "Tong Shu Luo Yu Luo Jia Tong Shu," 119.

[175] Luo, ed., *Ke Jia Shi Liao Hui Pian*, 164.

[176] Editors, "Zi Nü Ji Cheng Fu Qin Kan Yu Shi Ye 子女繼承父親堪輿事業," *Sing Tao Daily 星島日報* (Hong Kong), July 27, 2018, https://web.archive.org/web/20260409171633/https://www.stheadline.com/daily-hongkong/1311069/%E5%AD%90%E5%A5%B3%E7%B9%BC%E6%89%BF%E7%88%B6%E8%A6%AA%E5%A0%AA%E8%BC%BF%E4%BA%8B%E6%A5%AD.

The founder of the Cai almanac was named Cai Zuibai 蔡最白 (1845-1920). He was a gifted mathematician, and he studied in the Xuehai tang, the prestigious Guangzhou academy established by Ruan Yuan. Cai not only became an expert in the imperial curriculum, but he also studied new Western astronomy recently translated in Chinese.[177] Cai set up a pavilion for day selection and fengshui inquiries, which became the Zhenbu tang 真步堂.[178] The Zhenbu tang printed the almanac, which was variously titled the *Qizheng jingwei xuanze tongshu* 七政經緯選擇通書 and the *Qizheng jingwei lishu* 七政經緯曆書. In addition to the almanac, Cai also published books about mathematics and astronomy, including the *Qizheng hujiao tu suan* 七政弧角圖算 and *Chunqiu tianwen kao* 春秋天文考.[179]

Much like the Hong and Luo families, Cai constructed instruments, but his instruments were primarily a part of his own practice and that of the family rather than to be sold. He built a new celestial globe that reflected updated star charts (see Figure 2-6). The globe was a demonstration instrument for teaching new astronomy, and it was used as a simple calculator to support quick measurements.[180] The family also maintained a set of mathematical tables. These were unpublished materials, but they were a part of the calculation tables used in the construction of planetary positions and the ephemerides.[181]

[177] Cai Zuibai, *Qi Zheng Hu Jiao Tu Suan 七政弧角圖算* (Zhenbutang, 1895), 990059685710203941, Harvard-Yenching Library. Zhang Boxi preface, 1a-2b; Cai Zuibo preface, 1a-2b
[178] Ye Jiaqi, "Tong Shu Li Suan Xue Jia Cai Zuibai Yan Jiu 通書曆算學家蔡最白研究" (Masters Thesis, Donghua daxue, 2022), 19-21.
[179] Cai, *Qi Zheng Hu Jiao Tu Suan*.; Ye, "Tong Shu Li Suan Xue Jia Cai Zuibai Yan Jiu", 23-24.
[180] Cai, *Qi Zheng Hu Jiao Tu Suan*. j. 3, 19a-22b; Ye, "Tong Shu Li Suan Xue Jia Cai Zuibai Yan" 34-36.
[181] Ye, "Tong Shu Li Suan Xue Jia Cai Zuibai Yan Jiu", 36-39.



Figure 2-6: Image of the Cai family celestial globe. The celestial globe shares many similarities with the globes produced by Qi Yanhuai (see Chapter 4). Source: Sing Tao Daily

Commercial Shops

Families sold their almanacs for profit, and these family lineages had a significant place in the market because of their expertise. But not all almanacs were produced by such experts. The almanac market belonged to a subcategory of commercial publishing. During the Qing dynasty, Guangzhou and Foshan flourished as a center of book publishing. It especially expanded from the Jiaqing and the Daoguang periods.[182] Zhang Youmin lists by name twenty-three commercial houses for Guangzhou and another twelve for Foshan.[183] Other studies contribute more.[184]

The regional publishers produced similar literature to other regional commercial houses. They prioritized popular literature, including educational works, dictionaries, primers, religious texts, songbooks, and single-sheet prints. The songbooks of Guangzhou were unique, because they

[182] Zhang, *Zhongguo Yin Shua Shi*, 555-557.; Guangdongsheng difang shizhi, *Guangdong Sheng Zhi: Chu Ban Zhi 廣東省志：出版志* (Guandong ren min chu ban she, 1997), 58-59.
[183] Zhang, *Zhongguo Yin Shua Shi*, 556-557
[184] Luo Zhihuan, "Qing Dai Guangdong Bu Fen Shu Fang Ji Si Ren Ke Shu Jian Shu 清代廣東部分書坊及私人刻書簡述," *Lingnan Wenxian*, no. 2 (1993): 68–71.; Luo Zhihuan, "Qing Dai Guangdong Bu Fen Shu Fang Ji Si Ren Ke Shu Jian Shu Xu 清代廣東部分書坊及私人刻書簡述續," *Lingnan Wenxian*, no. 3 (1993): 75–81.; Guangdongsheng difang shizhi, *Guangdong Sheng Zhi: Chu Ban Zhi 廣東省志：出版志* (Guandong ren min chu ban she, 1997), 69-70.

used Cantonese and special characters to represent local speech.[185] Almanacs were a staple in these popular genres. Some of the commercial houses, such as Jujing tang 巨經堂, Sanyuan tang 三元堂, and Fuwen tang 福文堂, all included almanacs in their publication. But not all commercial printers engaged in almanac printing. For instance, Fuwen zhai 富文齋 and Hanmo yuan 翰墨園 were two major regional publishers, yet neither of these houses printed almanacs or at least not prominently based on extant bibliographies.[186] Drawing on surviving editions, there were two main commercial publishers and printers that dominated the popular almanac market: Dangui tang and Duowen tang. The following analysis is based on different components from individual almanacs in libraries and museums.

Dangui tang: In terms of almanacs, one of the most successful publishers was the Dangui tang 丹桂堂. The Dangui tang was a commercial publishing house based in Guangzhou. The publishing house was located in the center of the city near the student academies.[187] Based on various published editions, the Dangui tang sold classical biographies, popular novels, poetry, song books, and letter collections. Almanacs remained a staple of their catalogue.

The Dangui tang was one of the oldest and longest lasting commercial houses in almanac publishing. They had an early presence and were clearly established by about 1800. One of the earliest editions attached to the publishers is an eighteenth-century edition of a popular novel stating that it the blocks were held in Dangui tang.[188] There are other books that are more precisely dated to 1809 and 1816, where the front covers called on the readers to remember the trademark.[189] They were not the only printing house at the time. The Jujing tang also dated to this period. But the Dangui tang continued to publish throughout the nineteenth century. They even had an afterlife

[185] Mark Bender, "Regional Literatures," in *The Columbia History of Chinese Literature*, ed. Victor H. Mair (Columbia University Press, 2002), 1025-1028.
[186] Guangdongsheng difang shizhi, *Guangdong Sheng Zhi: Chu Ban Zhi 廣東省志：出版志* (Guandong ren min chu ban she, 1997), 70.
[187] Danguitang, *Dan Gui Tang Da Zi Qi Zheng 丹桂堂大字七政* (Danguitang, 1820), RM c.41.t.7(4), School of Oriental and African Studies, Morrison collection. Cover page
[188] Rulianjushi, *Fan Tang Yan Yi 反唐演義* (Danguitang, 1753), SINOL. 5764.Fan-T'ang.3, Leiden University, Special Collections.
[189] Danguitang, *Hou Xu Gu Jin Ji Shi Lu 後續古今紀事錄* (Danguitang, 1809), L.sin. D 324, Bayerische Staatsbibliothek.; Andrew West, *Catalogue of the Morrison Collection* (School of Oriental and African Studies, University of London, 1998), 134.

in the twentieth century as new publishers reused their blocks for continued popular novels, songbooks, and theater.[190]

Unlike the family lineages, the Dangui tang distinguished the publishing house and woodblocks from the production of the almanac. This is not to say that the publishing house was disconnected from family ownership. In fact, the Dangui tang was associated with a specific family, surnamed Su 蘇. The family is mentioned in advertisements about the publisher's location and some of the almanacs are even called the Su family Dangui tang almanacs.[191] But the family used its name as a trademark rather than as a sign of their expertise in almanac making. Early almanacs include references to someone named Ni Zhong 倪忠 who was the one who had the secret techniques used to create their distinct calendar work.[192] Hence, the Dangui tang had a popular almanac, but they were not necessarily known as the source of almanac knowledge or for related services.

The Dangui tang was a part of the book trade. They carved and printed the books. Hence, they shared their blocks and prints with several other shops in Guangzhou. Early editions state that one could visit either the Dangui tang store to purchase the almanac or one could go to other shops, such as the Pangui tang 攀桂堂 and the Fuxian tang 福賢堂.[193] Other genres attest to this practice as well. Songbooks state that the books were carved by the Dangui tang, but they were published by different houses.[194] Two books on theater connected the Dangui tang with the publisher called Rongde tang 榮德堂.[195]

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[190] For instance, see Xian qing ju shi, *Xin Zhuan Quan Ben Xiu Qiu Ji 新選全本繡球記* (Zui jing shu ju, 1912-1930), Hong Kong University Library.

[191] Two examples are Danguitang, *Dan Gui Tang Da Zi Qi Zheng*.; Danguitang, *Xianfeng San Nian Tong Shu 咸豐三年通書* (Danguitang, 1853), 990120901370203941, Harvard-Yenching Library.

[192] Fuxiantang, *Fu Xian Tang Da Zi Qi Zheng 福賢堂大字七政* (Fuxiantang, 1821), RM c.41.t.8(1), School of Oriental and African Studies, Morrison collection.

[193] Danguitang, *Da Qing Jiaqing Er Shi Wu Nian Tong Shu 大清嘉慶二十五年通書* (Danguitang, 1820), RM c.41.t.7(3), School of Oriental and African Studies, Morrison collection.; Fuxiantang, *Fu Xian Tang Da Zi Qi Zheng 福賢堂大字七政* (Fuxiantang, 1821), RM c.41.t.8(1), School of Oriental and African Studies, Morrison collection.; Danguitang, *Xianfeng San Nian Tong Shu*.

[194] Li Jiantian et al., "Mu Yu Shu Cang Shu Mu Lu 木魚書藏書目錄," Catalogue, June 8, 2022, http://ktim.ueuo.com/covers/pages/mukyushupdf.htm.

[195] Xian qing ju shi, *Xin Ke Shi Er Gua Fu Zheng Xi 新刻十二寡婦征西* (Danguitang, n.d.), 854295-98, Fu dan da xue tu shu guan.; Xian qing ju shi, ed., *Xin Ke Yang Jia Da Po Tian Men Chen Quan Ben 新刻楊家大破天門陣全本* (Danguitang, n.d.), 854291-94, Fu dan da xue tu shu guan.

In the final decades of the Qing, it is even possible that the Dangui tang became absorbed into a later publishing house called the Wugui tang 五桂堂. According to oral histories, the Wugui tang was founded by four brothers. It became one of the most popular regional commercial printers and publishers of the late Qing and early Republican era, eventually expanding to Hong Kong, southeast Asia, and even the Chinatowns in the United States. Those oral histories do not mention the Dangui tang trademark as a predecessor of the shop; but the Dangui tang and the Wugui tang shops were located on the same street, and the two shops shared similar blocks.[196] More research is required to clarify this connection.

Duowen tang: Although Dangui tang was one of the most significant printers in the first half of the nineteenth century, the Duowen tang 多文堂 became a major competitor in the second half. I have not been able to determine when exactly the printer started. But the earliest edition of their almanac I have found dates to 1874.[197] The publishers continued to produce their own almanac for several years. It existed into the Republican era with the last extant almanac coming from 1914.[198] The Duowen tang like the Dangui tang did not limit itself to almanacs. The publishers printed a copy of the *Thousand Character Classic*, and they collaborated with Cai Zuibai to print copies of his works as well.[199]

Yet the Duowen tang prioritized its almanacs. The first page of the almanac was a note from the house to the reader. The note stated that the Duowen tang relied on imperial sources to compile their almanac, and they worked to ensure that the almanac was useful for people.[200] Some years later, they updated the preface pages. Because several other publishers in Foshan had started to copy their almanac, they reiterated their focus on using official materials and called shame on the pirates.[201]

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[196] For instance, the edition held in Oxford states that the blocks are stored in Wugui tang, but it was printed by Dangui tang. Xian qing ju shi, ed., *Xin Ke Yang Jia Da Po Tian Men Chen Quan Ben 新刻楊家大破天門陣全本* (Danguitang, n.d.), Sinica 4921/1-2, Bodleian Library. For more information on the Wugui tang, see Guangdongsheng difang shizhi, *Guangdong Sheng Zhi: Chu Ban Zhi 廣東省志：出版志* (Guandong ren min chu ban she, 1997), 70.

[197] Duowentang, *Zou Ji Tong Shu 識吉通書* (Duowentang, 1874), 2012402059, Library of Congress.

[198] Duowentang, *Jia Yin Nian Tong Shu 甲寅年通書* (Duowentang, 1914), Sinica 3130, Bodleian Library.

[199] Zhou Xingsi, *Qian Zi Wen 千字文* (Duowentang, 1875), Asian Rare-5 no.481, University of British Columbia.; Cai Zuibai, *Chun Qiu Tian Wen Kao 春秋天文考* (Duowentang, 1875), 甲 950/7527, Qing hua da xue tu shu guan.

[200] Duowentang, *Zou Ji Tong Shu 識吉通書* (Duowentang, 1874), 2012402059, Library of Congress. 1a

[201] Duowentang, *Zhong Wai Ti Fu 中外禔福* (Duowentang, 1896), 9315.5233, University of California, Berkeley, East Asian Library. Preface, 1a

The almanacs distributed by the Danui tang and the Duowen tang were more like encyclopedias than calendars. Whereas family almanacs emphasized the transmission of teachings, commercial almanacs sold access to many kinds of information. The almanac compilers added notes to the pages encouraging consumers to read the almanac information carefully to understand how to use the techniques for fate calculation.[202] Secondly, the compilers incorporated wide sources of information in these almanacs. The Duowen tang almanacs included time-oriented information as well as medical recipes, opium treatment, vocabulary, political institutions, and more. The Duowen tang also created a special almanac that was specifically targeted to Chinese migrants living abroad. This almanac included even more helpful information, such as how to behave while on a steamship and additional sets of latitude timetables for different locations in the Pacific.[203]

Individual Makers

The majority of almanacs from South China belonged to either family lineages or branded almanacs. Nevertheless, there were also individuals who were involved in creating almanacs but who supplied and sold the information to printers separately. This might have been the case with the early advertisement from the Dangui tang stating that they used the almanac compiled by Ni Zhong. There is also a wide range of evidence from South China that indicates there were many people who had expertise in calendrical calculations and who sold these services. Some of these people used the published almanacs as their sources, but others created their own. Horoscopes, for instance, were compiled privately and in manuscripts.[204]

While we know few names of such people, some of the commercial almanacs do provide evidence that almanac publishing could serve as a platform for individuals with this expertise. This is most apparent with almanac publishers in Foshan. The Foshan printers were frequently accused of pirating, but they were also well-established printing businesses, producing additional copies of

[202] Duowentang, *Zou Ji Tong Shu 諏吉通書* (Duowentang, 1874), 2012402059, Library of Congress. Liu shi ri sheng ren wu jin tu, 1a

[203] Duowentang, *Zhong Wai Ti Fu 中外諦福* (Duowentang, 1896), 9315.5233, University of California, Berkeley, East Asian Library.

[204] For the wide range of options available to selling these skills, see Richard J. Smith, *Fortune-Tellers and Philosophers: Divination in Traditional Chinese Society* (Westview Press, 1991), 155-157, 200-201, 205, 238-239, 244-245. For an example of a horoscope, see Ronald Suleski, *Daily Life for the Common People of China, 1850 to 1950* (Brill, 2018), 175-198.

vernacular literature. In the case of their almanacs, some of these businesses attributed the calendar portion to one named Li Qisheng 李其生 whose name appeared as an editor.[205] Calendar pages in almanacs typically included a space in the top right corner for stating the editor of the calendar (see Figure 2-7). In family almanacs and in commercial almanacs, the calendar pages always attributed the name to the main publishing house. Calendar pages emphasized branding.

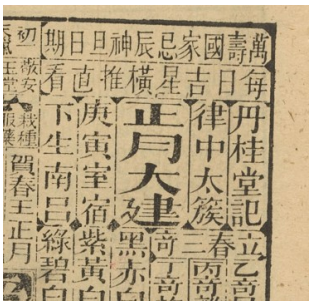

Figure 2-7: Close-up of calendar page in almanacs. Next to the large characters for the month, the business, family, or individual added their name as the primary editor of the almanac. Source: Dan gui tang Su ban da zi tong shu, 1886, 1a, Harvard-Yenching Library, 990084745890203941

However, in the case of these Foshan almanacs, businesses gave this position to Li Qisheng instead of their own trademark. One clear example of this practice appears in an 1890 edition of the almanac. In this case, the business used Li's name as the editor for almost every main page of the calendar with the exception of the intercalary month and two additional months.[206] In an 1880 almanac, the Sanyuan tang 三元堂 intermingled their business with Li's name.[207] Thus, the name of the editor for the month alternated between the business and Li for all the months in the year.

In sum, while most almanacs today are based on either a commercial publisher or a family heritage of almanac making, it is important to keep in mind that there were other ways to participate in almanac making. Commercial businesses were flexible in some ways, as bookshops and printers overlapped. South China almanac makers may have shared a similar practice noted in directory shops. In North China, directory publishers shared some woodblocks across different print shops

[205] Sanyuantang, *San Yuan Tang Zou Ji Tong Shu 三元堂諏吉通書* (Sanyuantang, 1880), Chinois 5046, Bibliotheque Nationale de France, Département des Manuscrits.; Weijingtang, *Zou Ji Tong Shu 諏吉通書* (Weijingtang, 1896), 990093152050203941, Harvard-Yenching Library.; Weijingtang, *Tong Shu 通書* (Weijingtang, 1890), CE 37.T97, Cornell University Library.

[206] Weijingtang, *Tong Shu 通書* (Weijingtang, 1890), CE 37.T97, Cornell University Library.

[207] Sanyuantang, *San Yuan Tang Zou Ji Tong Shu 三元堂諏吉通書* (Sanyuantang, 1880), Chinois 5046, Bibliotheque Nationale de France, Département des Manuscrits.

because they had similar sources of information. They produced books that had high levels of similarity across editions and publishing houses. Information such as the names of people for offices was shared. But individual shops distinguished themselves through their own contributions and distinct specialties.[208]

Following a similar logic in terms of calendars, South China printers shared high levels of similarity in the editions and the material they used. Variations often appeared through the types of additional comment added to this, whether unique pages from their own shop or like family lineages in special transmissions of technical expertise. Although one might assume that commercial printers were in opposition to the government, the texts from local publishers themselves show that commercial printers were more concerned about the pirating of their own specialty rather than concern about state regulation. Commercial printers generously connected their work to the empire, but they were also attuned to changing demands. So, by the late nineteenth century, almanac printers increasingly added information to almanacs that reflected changes in local conditions, with material on travel, language, and even timekeeping itself.

Designing an Almanac

The number of surviving almanacs illustrates how almanac making both reflected the imperial standards and how it offered a business model for entrepreneurs. Why were these books so successful? Commercial printers were strategic in designing their business to appeal to local readers. This included maintaining cheap prices and early entry into the actual market. But it also related to their unique approach to laying out pages and designing books for reading. Individual experts and commercial printers were able to use their different skillsets to make these books useful for readers. More than just combining sources, these printers and publishers designed new ways to access the content. These features of design shaped how people were supposed to read almanacs. Since these books were reference sources, publishers introduced creative strategies to increase the searchability of the book. The most important feature for this design was large character calendars.

[208] Emily Mokros, "Reading the Guides, Directories, Manuals, and Anthologies of Liulichang," *East Asian Publishing and Society* 7, no. 2 (2017): 143-144.

The origins of these designs can be traced to the late Ming commercial boom. Late Ming publishers were pioneers in designing new ways to engage with books and reading.[209] They offered readers choices. Shang Wei, for instance, has discussed this approach to readers in the context of popular novels.[210] Late Ming publishers combined genres in unconventional ways. They tended to reorganize the text into several layers or registers separated by a line. For popular novels, commercial editions tended to include at least two—more often three—registers throughout the entire book. Each register contained a different type of text. One register might contain the body of a piece of fiction while another register contained commentaries related to the novel. Other registers might exist alongside these chunks too, and these registers could contain popular songs, poetry, jokes, riddles, and other forms of entertainment.[211] This intertextual design was intentional. Commercial printers offered experiences, such that a reader had a choice where they wished to focus as they turned the pages.[212] Moreover, because these reading experiences also tended to combine illustration with text, it contributed even more to the sense of novelty and aesthetic pleasure of experiencing the novel.[213]

This attentiveness to readers contributed to what Bruce Rusk has described as a sensibility to "page-centered" design, i.e. the material response to pages that were meant to be framed as an interface for readers with intentionality regarding the placement of text in a limited space similar to magazine and newspaper design.[214] With popular encyclopedias, commercial printers followed the same practice as novels in using several registers of text organized by categories. But they also incorporated graphical layouts too. If a reader were to open a book, the binding structure of older

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[209] For the broader context of books and media format, see Robert E. Hegel, *Reading Illustrated Fiction in Late Imperial China* (Stanford University Press, 1998); Robert E. Hegel, "Niche Marketing for Late Imperial Fiction," in *Printing and Book Culture in Late Imperial China*, ed. Cynthia J. Brokaw and Kai-wing Chow (University of California Press, 2005); S. E. Kile, *Towers in the Void: Li Yu and Early Modern Chinese Media* (Columbia University Press, 2023).

[210] Wei, "The Making of the Everyday World."; Shang Wei, "Jin Ping Mei and Late Ming Print Culture," in *Writing and Materiality in China: Essays in Honor of Patrick Hanan*, ed. Judith Zeitlin et al. (Harvard University Asia Center, 2003).

[211] Shang Wei, "Jin Ping Mei and Late Ming Print Culture," in *Writing and Materiality in China: Essays in Honor of Patrick Hanan*, ed. Judith Zeitlin et al. (Harvard University Asia Center, 2003), 204-205.

[212] Shang Wei, "Jin Ping Mei and Late Ming Print Culture," in *Writing and Materiality in China: Essays in Honor of Patrick Hanan*, ed. Judith Zeitlin et al. (Harvard University Asia Center, 2003), 217.

[213] Robert E. Hegel, *Reading Illustrated Fiction in Late Imperial China* (Stanford University Press, 1998), 290-326; Yuming He, *Home and the World: Editing the "Glorious Ming" in Woodblock-Printed Books of the Sixteenth and Seventeenth Centuries* (Harvard University Asia Center, 2013), 77.

[214] Bruce Rusk, "Writer's Block or Printer's Block: The Book and Its Openings in Early Modern China," in *Impagination - Layout and Materiality of Writing and Publication: Interdisciplinary Approaches from East and West*, ed. Anthony Grafton et al. (De Gruyter, 2021), 274.

models created a disjuncture between the content of the two pages. Commercial publishers therefore took greater care to manage the relationship between the cutting of the woodblock, the printing of the pages, and the final binding format of the pages. This attention to detail resulted in enhanced reading experiences. Using grid paper and table organizers, commercial printers tried to integrate reading experiences into a cohesive set of information for any opening and page.[215]

In addition to designing more cohesive openings, commercial printers equally focused on costs. For this reason, they experimented with the page space too. Printers tried to maximize the size of the page with the highest amount of information they could fit into the page design. They removed almost any form of negative space from pages. They removed some information and reorganized other chunks in order to create smaller and cheaper editions. They were maximizing the focus on the woodblocks and printing to ensure that they were able to print as much information as possible per book. By following this *horror vacui* as Rusk calls it, printers eliminated the need to create extra pages for extraneous passages.[216]

The explosion of almanacs in the nineteenth century led to additional innovations in designing pages and information. The almanac printers in South China were certainly aware of these older commercial strategies. Almanacs shared similarities with encyclopedias. Both genres incorporated multiple sets of information compiled into a single reference book, but encyclopedias of daily life organized information by categories whereas almanacs generally did not use category organization. This introduced unique challenges for facilitating the engagement with almanacs. Almanacs rarely had a table of contents that sorted what was in the book. While late Ming commercial publishers had pushed for maximizing the reading space, commercial printers of almanacs started to create new graphic elements to allow readers to scan pages faster despite packing as much information as possible into the pages.

This was a change in how printers designed the layout for calendar pages. Calendar layouts had largely stabilized in form in the late medieval period with the rise of printing. Early calendars and private almanacs had existed in a variety of structures. Some of these early formats were particularly creative for how a user was supposed to manipulate the piece of bamboo or silk to find

[215] Rusk, "Writer's Block or Printer's Block," 281-285.
[216] Rusk, "Writer's Block or Printer's Block," 289-292.

a particular day.[217] But by the Song period, with the exception of single-sheet wall calendars, most calendars for daily use were organized around the pamphlet format and column layout.[218] The first column included the overall information about a month, such as the month's stem and branch combination, size of the month, color terms, weather information, and other relevant content. Then, each column continued with the day. Under each day column, the calendar compiler added auspicious activities, inauspicious activities, religious events, and so on.

As the standard format for official calendars, almanac makers initially copied this structure. The earliest extant almanacs from the Yongzheng and Qianlong periods look almost identical to imperial calendars. They might contain variations in the types of activities listed, and they might include different religious festivals for their local context, but the format is the same structure. They use the first column for the month's information, and they then produce the set of days in columns with their respective auspicious and inauspicious activities. The columns and the characters were of equal size, creating uniformity across the calendar.

However, South China almanac makers adapted this system with greater focus on readability. They called these new calendar styles "large-character" calendars *dazi tongshu* 大字通書. Large-character formats referred to the variation in sizes for each character used on a set of calendar pages. This did not mean that every character was larger. Rather large-character calendars introduced size as a highlighting technique and a hierarchical approach towards information. Although the calendars continued to follow the principle of no negative space, the new large-character format introduced visual and graphic features that enabled the reader to notice important forms of information at a glance.[219]

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[217] For examples of the different formats used in calendar manuscripts, see Alain Arrault, "Les Calendriers," in *La Fabrique Du Lisible: La Mise En Texte Des Manuscrits de La Chine Ancienne et Médiévale*, ed. Jean-Pierre Drège (Collège de France, Institut des hautes études chinoises, 2014), 101-116.; Donald Harper, "Daybooks in the Context of Manuscript Culture and Popular Culture Studies," in *Books of Fate and Popular Culture in Early China: The Daybook Manuscripts of the Warring States, Qin, and Han*, ed. Donald Harper and Marc Kalinowski (Brill, 2017), 110-116.; Luke Waring, *Writing and Materiality in Ancient China: The Textual Culture of the Mawangdui Tombs* (Columbia University Press, 2025), 161-184.

[218] Alain Arrault has shown this change over time with his studies of Dunhuang calendars. Alain Arrault, "Les Premiers Calendriers Chinois Du IIe Siècle Avant Notre Ère Au Xe Siècle," in *Les Calendriers: Leurs Enjeux Dans l'espace et Dans Le Temps : Colloque de Cerisy, Du 1er Au 8 Juillet 2000*, ed. Jacques Le Goff (Somogy, 2002); Arrault and Martzloff, "Calendriers."

[219] By the late Ming, printers had internalized a sense of grid as a way to standardize production of layouts and page sizes. But these new designs expanded on the grid structure with much more flexibility. For this idea of the grid, see Martin Heijdra, "Typography and the East Asian Book: The Evolution of the Grid," in *The Scholar's Mind: Essays in Honor of Frederick W. Mote*, ed. Perry Link (Chinese University Press, 2009).

The term large-character calendars and large-character almanacs started to appear in the early nineteenth century. Commercial printers were the first to introduce these titles rather than the lineage-based almanac makers. The earliest extant example for a calendar using the term is a Dangui tang calendar dating to 1820, which was purchased by Robert Morrison.[220] Some of the other commercial houses quickly followed suite, with other cases of large-character calendars being listed in 1824 and spreading quickly.[221]

These new formats introduced hierarchies that reorganized how blocks of information were set into the pages (see Figure 2-8). Large characters guided the reader like headings or subtitles. So, for each large character one could use that as a reference on the page. This meant that the new layout increased the size of the month and the size of the day. One could open a page of the calendar and quickly find the relevant day. Large-character sizes were nearly four times as large as previous character designs.



Figure 2-8: Image of a Large-character Calendar. The calendar includes large sizes for all of the heading entries, such as auspicious spirits, inauspicious stars, and the row of individual dates. Notice as well in the bottom half that the calendar uses boldface features to make additional highlights for other elements. Source: Da quan tong shu Daoguang si nian, 1824, 1a, Staatsbibliothek zu Berlin, Libri sin. 168

[220] Danguitang, *Dan Gui Tang Da Zi Qi Zheng*.
[221] Guangwentang, *Guang Wen Tang Da Zi Qi Zheng 廣文堂大字七政* (Guangwentang, 1824), RM c.41.t.7(10), School of Oriental and African Studies, Morrison collection.; Jujingtang, *Daoguang Jiu Nian Tong Shu 道光九年通書* (Jujingtang, 1829), Sin 186-C ALT SIN, Österreichische Nationalbibliothek.; Fuwentang, *Can Ding Da San Pian Tong Shu 參訂大三篇通書* (Fuwentang, 1852), SINOL. 1749.7 (I), Leiden University, Special Collections.

Large characters emphasized important information. This was both about position and visualization. Official calendars prioritized the information of "what to do", i.e. what was the most beneficial. They placed negative information at the bottom of the columns. Commercial printers, on the other hand, flipped this information around when they started making large-character calendars. They placed "what not to do" at the top of the page. One could then open the calendar and find the day faster because of the size. Then, one could look at the row above the day entry to see the restricted activities for the day. Since it was better to know what to avoid, this information became the fastest one to highlight.

A second visual component of large character calendars was contrast. Because the page was full of information, the size of the character also related to background contrast. The new pages included carving features that added dark backgrounds against the characters to make them stand out. In the past, woodblock carvers had used similar contrast to create headings and highlights in Song and Yuan imprints.[222] These new large-calendar formats used the technique to greater effect as they targeted various types of information to guide readers. That included highlights on particularly inauspicious days or highlights for seasonal transitions. Despite densely packing the page space with filled-in boxes, visual elements created hierarchies that enabled a reader to glance and scan the information quickly while perusing the calendar. Large-character almanacs were easier to read then official calendars.

Large characters were known for readability. During the Song and Ming, there were already some books that were called large format editions *daziben* 大字本. These books were often religious and classical editions. They included larger sizes of characters per column in order to increase legibility.[223] This term also existed in the commercial print culture too. Some novels were printed in larger sizes and were called large-character editions for similar reasons.[224] But these earlier terms mostly referred to the use of a large-character for the entire column. While editions with commentaries could use both larger and smaller character sizes to refer to the main text and

[222] Lucille Chia, *Printing for Profit: The Commercial Publishers of Jianyang, Fujian (11th–17th Centuries)* (Harvard University Asia Center, 2003), 46-47.
[223] Chia, *Printing for Profit*, 42-43.; Shih-shan Susan Huang, "Early Buddhist Illustrated Prints In Hangzhou," in *Knowledge and Text Production in an Age of Print: China, 900-1400*, ed. Lucille Chia and Hilde De Weerdt (Brill, 2011), 153, 155. ; Scarlett Jang, "The Eunuch Agency Directorate of Ceremonial and the Ming Imperial Publishing Enterprise," in *Culture, Courtiers, and Competition: The Ming Court (1368–1644)*, ed. David M. Robinson (Brill, 2008), 125.
[224] Wang Shifu, *Xin Kan Da Zi Kui Ben Quan Xiang Can Zeng Qi Miao Zhu Shi Xi Xiang Ji 新刊大字魁本全相參增奇妙註釋西廂記*, Xuxiu Siku Quanshu 續修四庫全書 1765 (1498, n.d.).

the commentary, the large characters were still used as a main format for the entire body. These new examples of large character calendars differed from this tradition in two ways. First, the "large-characters" in the calendars were significantly larger than earlier sizes. Secondly, these calendars used large characters as a form of emphasis and boldface, not just as a style for the entire printed text.

Although the term *dazi tongshu* only appeared during the Jiaqing period, some almanacs attest to the fact that printers were already experimenting with graphical approaches to information in the eighteenth century. An almanac from 1754 predated the commercial explosion in almanacs. Nevertheless, it showed an intermediate adaptation in design. Titled like an encyclopedia for daily use, the almanac was a "Full collection of explanations for convenient and daily perusal". The calendar, which made up the last portion of the booklet, contained new visual features. The designer used contrast and highlights to accentuate important characters and information units. But it did not go so far as to use large characters for anything other than the title of the month. Although the calendar did use a set of circles to distinguish calendar columns, a technique that had a longer history in calendar annotations, the calendar maintained the basic organization of inauspicious information at the bottom.[225]

Commercial printers, in fact, never stopped experimenting and refining the calendar layouts. Following the introduction of the "large-character" calendars, commercial printers continued to improve the design. For example, later printers increased the size of the first day of the month to make it even more prominent than any other day (see Figure 2-9). By almost doubling the size again, the column for the first day allowed the reader to quickly see inauspicious activity for that specific day. Later prints gave similar treatment to other days like the twenty-four seasonal joints.[226]

[225] Yingshitang, *Qianlong Shi Jiu Nian Ri Yong Bian Lan Zong Jie Da Quan 乾隆十九年日用便覽總解大全* (Yingshitang, 1754), Libri sin. 87, Staatsbibliothek zu Berlin.

[226] Danguitang, *Xianfeng Si Nian Tong Shu 咸豐四年通書* (Danguitang, 1854), 990084745880203941, Harvard-Yenching Library.; Duowentang, *Zou Ji Tong Shu 諏吉通書* (Duowentang, 1874), 2012402059, Library of Congress.; Danguitang, *Dan Gui Tang Da Zi Zou Ji Tong Shu 丹桂堂大字諏吉通書* (Danguitang, 1885), 9315.1885, University of California, Berkeley, East Asian Library.

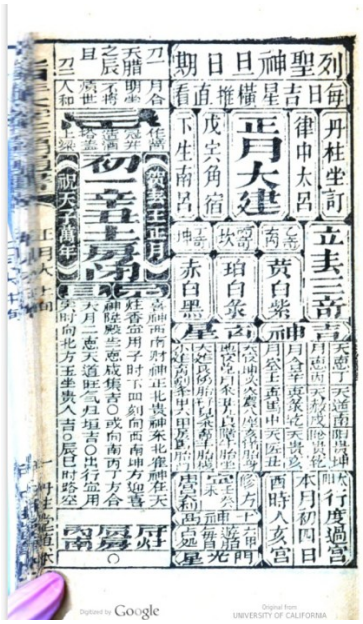

Figure 2-9: Later edition of Large-character Calendars. This example of a large-character calendar from the second-half of the nineteenth century increased the sizes of the days even further. It also created boldface notes to give quick references for the information related to the year, month, and day. Source: Danguitang, Dan Gui Tang Da Zi Zou Ji Tong Shu (Danguitang, 1885), 9315.1885, University of California, Berkeley, East Asian Library

One of the most prominent innovations was the introduction of color on the calendar pages. Although calendars were one of the earliest models of multi-color printing, private almanac makers used the technology strategically for reading. Earlier models did use two colors, but the pages were associated with a specific color rather than two colors on a single page. This meant that when they produced the blocks, they created separate blocks for black ink and red ink. Imperial prints did use multiple colors, but almanacs were almost always printed in black ink only. However, in the second half of the nineteenth century, color printing had a particular growth in South China. Guangzhou printers used colors to appeal to audiences.[227] Calendar pages then started to use two colors on each page. This meant that calendar pages underwent two rounds of printing, first in black and then in red ink. Since these pages were already packed with information, printing with multiple colors meant that the printers had to be especially conscious of the layouts and design and coordinate this process in multi-color printing. But the introduction of color enhanced the other

[227] Fang Renshu, "Guangdong Ban Ke Ji Shi 廣東板刻紀事," in *Li Dai Ke Shu Gai Kuang 历代刻书概况*, ed. Shanghai Xin si jun li shi yan jiu hui: Yin shua yin chao fen hui (Yin shua gong ye chu ban she, 1991), 513.

visual features of highlight and size. Color now could be a second category used to showcase auspicious information on a calendar page.[228]

These experiments in page layout and design reached a new height with the introduction of new printing technologies. Commercial printers in Guangzhou and Foshan advertised their purchase of typography to create similar effects and looks from the traditional methods. Although woodblock printing focused on the entire block, commercial printers had already started to be trained in thinking about page design in terms of elements like size and position. Typography then enhanced their goals to create distinct units of information that were packed together around hierarchical components that guided the reader across the page space. Calendars and almanacs printed with typography maintained these older practices of *horror vacui*, yet they also enhanced the newer practices of highlighting information units and building key types of layouts.[229]

2.3 Conclusion

The surviving almanacs from South China offer a glimpse into the intricate relationships that allowed these items to remain so popular. Almanac makers responded to the market. They were able to create books that were easy to use and search. For basic questions, such as what should one do for today, almanac makers created more accessible tools than imperial calendars. Similar to the reading guides and innovations used in publishing legal literature, almanac makers thought about their readers and adapted their tools to make sure that they responded to these issues.[230]

Despite the small elements of difference in almanacs, and the many different sources of information these makers used to compile these books, almanac makers prioritized orthodoxy. Throughout this chapter, I have noted that almanac compilers stressed their relationship to the government. In the prefaces to almanacs, almanac makers made sure to reference imperial sources of information. Families that specialized in day selection services spoke about their transmission of skills but also constructed narratives of their family relationship to the imperial astronomical

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[228] Danguitang, *Dan Gui Tang Da Zi Zou Ji Tong Shu 丹桂堂大字諏吉通書* (Danguitang, 1885), 9315.1885, University of California, Berkeley, East Asian Library.; Wen guang lou, *Xin Tong Shu*.

[229] Wen guang lou, *Xin Tong Shu*.; 天寶樓 Tianbaolou, *Tian Bao Lou Ji Qi Hong Zi Tou Tong Shu 天寶樓機器紅字頭通書* (Tianbaolou, 1905), 990080512750203941, Harvard-Yenching Library.

[230] Ting Zhang discusses how commercial printers also tried to incorporate searching and scanning elements, with highlights, external topics and headings, and indexes to facilitate searching through the law code. Ting Zhang, *Circulating the Code: Print Media and Legal Knowledge in Qing China* (University of Washington Press, 2020), 107-108.

bureau. Commercial businesses also tried to incorporate references to the textbooks or the imperial source of the official calendar as a reference to justify and authenticate their books. As noted about the Jicheng tang, even when other houses tried to engage in pirating, almanac makers would rely on the government as a support to their almanacs.

These practices of almanac making shed light on the larger relationship between private printing and the state. Although almanac printing was initially frowned upon as a destructive practice, the government came to support almanac printing over time because it helped circulate temporal information. Almanacs could fall into the category of unorthodoxy if calendar compilers were careless in the construction of stems and branches and if they published information that was too radical to the government. But if almanacs relied on the imperial calendar as the primary source of authority for the calendar, almanacs offered a cheap solution for reproducing calendars and reaching more audiences.

Nevertheless, some of the cases from the end of the Qing dynasty point toward a deeper problem that resulted from the permission granted to almanacs. The rise of markets in time also meant that it created opportunities for selling alternative forms of time. Missionary cases and treaty ports are clear examples where the market for time produced alternative calendars that undermined state orthodoxy. Although the majority of almanac makers followed the traditional calendar, the relaxation of the controls over calendar markets did promote other visions of time to circulate. This in turn impacted the almanac markets. Alternative almanacs found refuge in Treaty Ports, but so too did traditional almanacs start to respond to these demands. The South China almanac makers increasingly started to add more information that allowed their readers to use the almanacs in multiple spaces. These transitions allowed for new vocabularies and even the production of new calendars to allow users to understand the relationship between the Gregorian calendar and the Chinese lunar calendar. This tension was never fully resolved, but it can be traced by looking at these editions and the ways in which commercial printers tried to support readers and respond to other changes.

Since the government introduced looser restrictions over the control of time, how did these rules and regulations impact other aspects of measuring time? The next chapters take up this question with other temporal media. Chapter 3 turns to dialing technologies and statecraft, while chapter 4 examines clockwork. These chapters suggest that the rise of this “market for time” and the permission to sell time created a gap for competing theories of time. These could be focused

on arguments for increasing state control and in creating greater opportunities for different actors. Markets for time were innovative spaces for adapting models to traditional theories of time.

Chapter 3 Time Reform, Ritual Precision: Zhang Zuonan and Instruments of Time

In 1820, Zhang Zuonan took up a new position as the district magistrate of Changzhou, a city located near Suzhou in Jiangsu province. Within the year, he had commissioned two monumental sundials to be built in the Buddhist temple complex in the center of the city. The first sundial was a direct east-west vertical sundial. The second was a horizontal sundial located on the opposite end of the courtyard. The two dials, which are still standing today, were built from local stone and were covered in the classical divisions for measuring hours with the stems and branches and dividing the year into the seasonal markers. According to the inscriptions on the dials, the two dials had several functions. Naturally, they told time, but they also addressed why that time mattered. The objects were intended to be illustrations for mathematics. By highlighting the concepts of spherical trigonometry and coordinate systems in measuring time, Zhang wished to use these instruments as a form of practical astronomy. These sundials were not just monuments of time. They were also the materials for Zhang's vision of precision.[1]

Throughout his career, Zhang created instruments and published books explaining why he cared so much about time and mathematics.[2] For Zhang, timing was about ritual. These sundials used the geometry based on Western Learning to explain how the ancient rituals for finding time had worked and how they provided templates for adapting those rituals to specific places. The interplay between ritual and time informed why Zhang viewed time reform as a practical field of statecraft. From about 1810 to 1840, when Zhang was serving in different official capacities

[1] Two previous studies have examined components of this research. These two works provide some analysis of the design of the sundials and issues in preservation. For one study on Zhang's sundials, see Deng Kehui, "Mian Dong Xi Ri Gui Zai Qing Dai de Fa Zhan 面東西日晷在清代的發展," *Zhongguo Keji Shiliao* 20, no. 1 (1999): 74–80. Guo Shengchi, "Changzhou Tianning Si Qing Dai Ri Gui Ji Qi Fu Yuan She Ji 常州天寧禅寺清代日晷及其复原設計," *Shanghai Tian Wen Tai Nian Kan* 14 (1993): 303–9.

[2] There are several biographical sources about Zhang and his scholarship. In the context of Confucian schools, see Xu Shichang, *Qing Ru Xue an 清儒學案*, Qing Ru Xue An (Zhonghua shu ju, 2008). j. 128, 5055-5056. For Zhang in the context of mathematics, see Luo Shilin, *Chou Ren Zhuan Xu Bian 疇人傳續編*, vol. 516, Xuxiu Siku Quanshu 續修四庫全書 (1840). j. 52, 17b-20a, 523-524. Most recently, one of Zhang's descendants has compiled a complete biography about Zhang combining local historical sources, poetry, and other related materials. Zhang Genfang, *Zhang Zuonan Nian Pu 張作楠年譜* (Zhu hai chu ban she, 2010).

throughout Jiangnan, the Zhejiang native helped navigate multiple crises in famine, food, weather, and social unrest. Following in the footsteps of Confucian pragmatists who advocated for local gentry activism and promoted the idea of Confucian public duty, Zhang treated ritual reform as the moral foundation for social reform. Understanding mathematical tools and astronomical theories of precision became his model for teaching ritual precision and trying to create social cohesion in a period of crisis. Zhang consequently built astronomical, mathematical, and timekeeping instruments that translated specialized skills for those he referred to as "the scholars among the grasses."

Expanding on the market for time, this chapter explores time reform through Zhang Zuonan and his instruments. Although almanac makers sold time for the purpose of profit, Zhang argued for selling time because it was useful and improved society. Zhang Zuonan used the popular market to promote education and improvement. While Zhang's ideas only sporadically reached national attention, his theories of time reform impacted local scholarship: Suzhou, Changzhou, Hangzhou, and others. Combining Zhang's instruments and publications about them with additional sources, this chapter defines Zhang Zuonan's practice through the language of precision and ritual.

Zhang's mathematical and astronomical instruments highlight two important themes. First, these instruments offer a chance to situate mathematics within its larger social and material context. Although some scholars have mentioned Zhang's instruments, historians have typically cited these tools in passing without further explaining how they functioned, why he and his friends started building them, or how these instruments shaped his theories of statecraft.[3] In the early 2000s, historians of Chinese mathematics situated Zhang Zuonan within the early nineteenth-century debates over Western Learning and the rediscovery of native mathematics. This research recognized Zhang's unique approach, even though these studies focused more on his mathematical contribution than instruments.[4] Building on this foundation, my study introduces how instruments

[3] For instance, Pan Nai has provided one of the more detailed analyses of Zhang's sundials, but they are not situated into any other context apart from being sundials that were influenced by Western astronomy and mathematics. Pan Nai, *Colour Printing: The History of Ancient Astronomical Instruments of China 彩圖本：中國古天文儀器史* (Shaanxi jiao yu chu ban she, 2005). 108-114

[4] The two most important studies are Lin Cangyi, "Zhongguo Qing Dai 1723-1820 Nian Jian de Jie Gen Fang Yu Tian Yuan Shu 中國清代 1723~1820 年間的借根方與天元術" (Masters Thesis, National Taiwan Normal University, 2002). 54-55; Lin Minzhi, "Qing Dai Suan Xue Jia Zhang Zuonan Ji Qi Suan Xue Yan Jiu 清代算學家張作楠及其算學研究" (Masters Thesis, National Taiwan Normal University, 2003).

not only shaped Zhang Zuonan's astronomy and mathematics but also how Zhang used these tools to popularize these practices beyond the bureaucracy and imperial capital.

Secondly, by locating Zhang's instruments within the social world of classical philology and practical statecraft, this chapter contributes a new analysis on statecraft and local society in the Jiaqing and Daoguang periods, namely that technology and the culture of making impacted theories of governance through the category of ritual.[5] Zhang Zuonan and his collaborator Qi Yanhuai belonged to what Man-houng Lin calls the "accommodationist school" of statecraft.[6] Accommodationists included more famous scholars like Bao Shichen 包世臣 (1775-1855), Lin Zexu 林則徐 (1785- 1850), and Wei Yuan 魏源 (1794- 1857). As realists who accepted that the state was struggling to recover finances, they advocated for market forces and called for local gentry to participant in management. In this framework, the "accommodationist school" existed in opposition to the interventionists, who included figures like Guan Tong 管同 (1780–1831), Liang Zhangju 梁章鉅 (1775-1849), and Wu Jiabin 吳嘉賓 (1803-1864). This school supported government intervention in the market because they were skeptical of profit as a motive for social good, but they encouraged the state to become more involved in diplomacy to oversee foreign merchants within the state's economic system.[7] The case of Zhang Zuonan and his instruments of statecraft demonstrates a third model that focused on pragmatism. While Zhang Zuonan agreed with market solutions founded on moral duties, he also rejected the debate between native and foreign traditions. He instead promoted values of efficiency and precision.

The following sections trace this context moving from the practical tools of astronomy to the application of tools to statecraft. The first section gives some background on precision by exploring how scholars and astronomers defined precision in this period. Section two turns to the material practices of precision. Zhang Zuonan used logarithms, sectors, magnetic compasses, and portable sundials as practical applications for mathematics. Section three continues this analysis by exploring what I call ritual precision. Ritual precision offered justifications for using these tools

[5] My study complements Ori Sela's call to place ritual as the third category connecting science and statecraft in the mid-Qing. Ori Sela, "Between Private and Imperial: Toward a New Understanding of Qing Science, Ritual, and Statecraft," in *The Sinosphere and Beyond: Essays in Honor of Joshua Fogel* (De Gruyter, 2024).
[6] Man-houng Lin, *China Upside Down: Currency, Society, and Ideologies, 1808–1856* (Harvard University Asia Center, 2006). 205
[7] For a comparison of these views in terms of human nature, the state, commerce, and markets, see Lin, *China Upside Down*. 203-227

to improve society. By connecting timekeeping to classical rituals for social organization and governance, Zhang Zuonan placed astronomical tools within gentry politics.

3.1 Precision in Late Imperial China

In late imperial China, there were several terms that all meant "precision." The terms carried the sense of exactness, repeatability, and analysis. The most critical, although not exclusive, terms were *jing* 精, *mi* 密, and *he* 合. These words rendered precision into spatial and tactile metaphors.[8] They described "precision" as occupying a space and coming together in a fixed way. Take the case of *jing*. This term has a rich heritage in Chinese. It could refer to genius and craftsmanship, and it often described skilled artisans. In the context of measurement, it usually meant something like "fine-grained", "refined", "detailed", "within a small degree." Similarly, the term *mi* carried a spatial metaphor: "tightness", "closeness" "density". *He* by contrast extended closeness to the point of contact around the object, much like "combined", "together", "joined", "in agreement". When put together, these phrases could add layers to precision, such as *jingmi* "close precision" or *mihe* "fit precisely together". Precision meant fit, as in a close connection between the predicted result and the actual outcome. Fit also had a sense of scale as it became increasingly closer and smaller as one tried to measure it. In referring to discreteness under smaller units, *jingmi* especially expressed the "exactness" of this form of precision.[9]

But what did this mean in practice? What distinguished one measurement from being more refined than another? Before moving more closely to the case of Zhang Zuonan, it is necessary to understand some of the practices that shaped technical precision in this context. The following sections discuss practices regarding precision to lay the groundwork for Zhang's instrument making and publishing. I focus on two fields that directly impacted Zhang's definitions, namely court astronomy and philology.

[8] Yulian Wu has also recently suggested that tactile metaphors of hardness and softness were integral to the culture of stonemasons and gemstone artisans at the Qing court. Yulian Wu, "Treasure Sand: Management of Abrasive Minerals in Qing Court Production," LRCCS Lecture, University of Michigan, Ann Arbor, November 11, 2025.
[9] The language of precision here shares some of the larger concern about exactness in order to gain control and to create order. M. Norton Wise, "Introduction," in *The Values of Precision*, ed. M. Norton Wise (Princeton University Press, 1997). 5. Similarly, a recent edited volume has emphasized that precision has long carried a sense of expectation and future within its definition. Sibylle Gluch, "Promises of Precision: Questioning Precision in 'Precision' Instruments," *Annals of Science* 81, nos. 1–2 (2024): 1–9.

Precision in Court Astronomy

Court astronomers practiced precision through the division of time units into small chunks and the verification of celestial phenomena with tools and instruments. Astronomical units of measurement were significantly smaller than the measurements used in everyday life. While most individuals cared about auspicious hours, astronomers cared about measurement below the hour. They worked in minutes and even divided minutes into seconds and microseconds which were called *miao* 秒 and *wei* 微. Those terms had classical origins, and they were used periodically in Chinese astronomy during various calendar crises for refining constants.[10] Following the introduction of Western reforms and the publication of the new calendar, Chinese astronomers started to consistently report these levels of measurement for various recurring events.

For example, in the Qing period, court astronomers had to prepare eclipse prediction down to the second for all locations of the empire. The astronomers submitted these reports in advance of an eclipse with the time calculated in terms of Beijing. But the time reports were also calculated for other locations. Since eclipses were visible depending on one's latitude, eclipse reports had to provide simultaneous time data in reference to one's location. The Ministry of Rites had to send these reports to the provinces that were impacted by the eclipse so that the local officials could conduct the necessary rituals that were associated with the phenomenon. This time data had a purpose in the context of presenting accurate and timely predictions about celestial events.[11]

When working with large numbers, court astronomers developed efficient methods that reinforced this value of precision. Court astronomers relied on forms and tables to guide their calculations. These templates were called *suanshi* 算式 or calculator forms (see Figure 3-1). Similar to an Excel spreadsheet, these guides had columns and rows for constructing a multi-step calculation. The user followed the instructions to fill in the blanks, calculate a procedure, and then

[10] Thatcher Deane argues that the Ming instruments would not have been particularly precise beyond six minutes of arc as a general practice. Thatcher E. Deane, "Instruments and Observation at the Imperial Astronomical Bureau during the Ming Dynasty," *Osiris* 9 (1994): 136-137. But during the calendar reforms, accuracy was expected to be less than one ke or within about 14 minutes. Willard J. Peterson, "Calendar Reform Prior to the Arrival of Missionaries at the Ming Court," *Ming Studies*, no. 1 (1986): 51-52.; Elman, *On Their Own Terms: Science in China 1550-1900*. 79-80

[11] *Qin Ding Da Qing Hui Dian (Qianlong)*. j. 86, 3a-3b. For illustrations of this type of data, see Zhongguo di 1 li shi dang an guan, *Qing Dai Tian Wen Dang an Shi Liao Hui Bian 清代天文檔案史料匯編* (Da xiang chu ban she, 1997). 332

move the sum to another section for additional processing.[12] Knowing how to build and use these forms was considered a "trade secret" of lineage astronomers and the Chinese astronomical bureau. When Korean astronomers visited Beijing to learn about the new system, they often tried to acquire manuscript documents that included these kinds of procedures to better understand how to implement the system.[13] While there were critics who believed that the use of calculation aids like these forms encouraged rote procedure rather than depth of knowledge about astronomy, the forms produced habits of precision.[14] They promoted the use of rows and columns for calculations, and the cells created a spatial model for time. The user placed units of time into quantitative boxes that enabled comparison and analysis.[15]

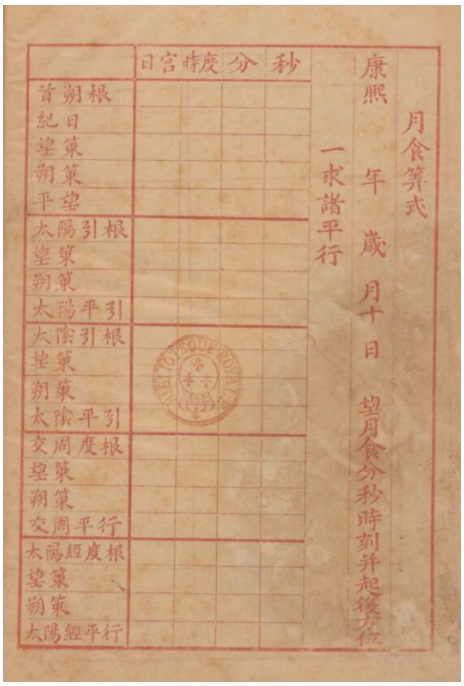

Figure 3-1: Blank Astronomical Form. The form can be filled out for the date and year. Each column relates to units of measurement. The rows correspond to the various constants, procedures, and sums that one must follow in order to

[12] [12] Liang Li, "Template Tables and Computational Practices in Early Modern Chinese Calendric Astronomy," *Centaurus* 58 (2016): 26–45. These template methods initially appeared as the Chinese astronomical bureau adapted some of the knowledge from the Islamic bureau. For more details on this process, see Yunli Shi, "The Korean Adaptation of the Chinese-Islamic Astronomical Tables," *Archive for the History of Exact Sciences* 57, no. 1 (2003): 25–60.; Liang 李亮 Li, "Arabic Astronomical Tables in China: Tabular Layout and Its Implications for the Transmission and Use of the Huihui Lifa," *East Asian Science, Technology, and Medicine* 44 (2016): 21–68.
[13] Li, "Template Tables and Computational Practices in Early Modern Chinese Calendric Astronomy." 38-41
[14] Li, "Template Tables and Computational Practices in Early Modern Chinese Calendric Astronomy."41-42
[15] Jack Goody, *The Domestication of the Savage Mind* (Cambridge University Press, 1977). 68-71; Matthew Daniel Eddy, *Media and the Mind: Art, Science, and Notebooks as Paper Machines, 1700-1830* (University of Chicago Press, 2023). 366-374

calculate the times for the lunar eclipse. Source: Qintianjian, "Tian Xiang Ji Lu Biao," Print, 1722 1662, Chinois 5015, Bibliotheque Nationale de France, Département des Manuscrits.

In addition to these traditional aids, Qing court astronomers used several new mathematical tools to handle large calculations. Many of these tools formed a part of the formal mathematics curriculum taught in the *Suanxue guan* 算學館 College of Mathematics.[16] These tools included logarithmic and trigonometric tables, algebraic methods, pen-based mathematics, and other forms of mechanical aids in calculation. Although some of this literature had existed since the late Ming because of translations from the Jesuits, court astronomers had direct access to the teaching. Before joining the astronomical bureau, prospective court astronomers had to study at least briefly in the College of Mathematics. The curriculum was managed by both foreign missionaries—usually Portuguese—and Chinese astronomers who had achieved some recognition for their mathematical prowess.[17] While the purpose of the mathematics department was primarily about numeracy and understanding how to do calculations for the production of the calendar, the mathematics department taught cossic algebra or *jiegenfang* 借根方 as a method for solving problems with unknowns.[18]

[16] For the history of mathematical training, see Catherine Jami, "Learning Mathematical Sciences during the Early and Mid-Ch'ing," in *Education and Society in Late Imperial China, 1600-1900*, ed. Benjamin A. Elman and Alexander Woodside (University of California Press, 1994). 223-256; Limin Bai, "Mathematical Study and Intellectual Transition in the Early and Mid-Qing," *Late Imperial China* 16, no. 2 (1995): 23–61. Chang, *The Chinese Astronomical Bureau, 1620-1850*.152-156

[17] Jami, *The Emperor's New Mathematics*. 200-213; Chang, *The Chinese Astronomical Bureau, 1620-1850*.152-156

[18] For additional details on translating Western algebra and its position in China, see Yan Li and Shiran Du, *Chinese Mathematics: A Concise History*, trans. John N. Crossley and Anthony W. C. Lun (Clarendon Press, 1987). 220-222; Catherine Jami, *Les Méthodes Rapides Pour La Trigonométrie et Le Rapport Précis Du Cercle (1774): Tradition Chinoise et Apport Occidental En Mathématiques* (Collège de France, Institut des hautes études chinoises, 1990). 67-96; Jami, *The Emperor's New Mathematics*. 200-213, 300-305, 352-354; Han Qi, "Kangxi Shi Dai Chuan Ru de Xi Fang Shu Xue Ji Qi Dui Zhongguo Shu Xue de Ying Xiang 康熙时代传入的西方数学及其对中国数学的影响" (Phd Dissertation, Institute for the History of Natural Sciences, 1991).; Miao Tian, "Jiegenfang, Tianyuan, and Daishu: Algebra in Qing China," *Historia Scientiarum* 9, no. 1 (1999): 102–106.; Lin Cangyi, "Zhongguo Qing Dai 1723-1820 Nian Jian de Jie Gen Fang Yu Tian Yuan Shu 中國清代 1723~1820 年間的借根方與天元術" (Phd Dissertation, National Taiwan Normal University, 2002).; Han Qi, "Xi Fang Shu Xue de Chuan Ru He Qian Jia Shi Qi Gu Suan de Fu Xing: Yi Jie Gen Fang de Chuan Ru He Tian Yuan Shu Yan Jiu de Guan Xi Wei Li 西方數學的傳入和乾嘉時期古算的復興: 以借根方的傳入和天元術研究的關係為例," in *Zhongguo Shi Xin Lun: Ke Ji Yu Zhongguo She Hui Fen Ce 中國史新論: 科技與中國社會分冊* (Lian jing chu ban she, 2010).459-486; Wei Xuegang, "Qian Jia Suan Xue Jia Dui Jie Gen Fang Yu Tian Yuan Shu Kan Fa de Zhuan Bian 乾嘉算學家對借根方與天元術看法的轉變," *Zhongguo Keji Zazhi* 40, no. 4 (2019): 402–11. For additional notes on the Nine Chapters, see Roger Hart, *The Chinese Roots of Linear Algebra* (Johns Hopkins University Press, 2011).; Kangshen Shen et al., *The Nine Chapters on the Mathematical Art: Companion and Commentary* (Oxford University Press, 2023).

The calendar reforms in the seventeenth century and the introduction of new mathematical practices generated significant levels of confidence in the standards of precision and the techniques used to produce them. By the end of the seventeenth century, these methods were considered so reliable that they were not usually questioned. Even when the observation of an eclipse by the Kangxi Emperor did not align with the prediction, the astronomers claimed that they had made arithmetic errors rather than there being any type of structural problem with the methods.[19] In 1824, Zhang Zuonan shared this confidence in the methods from the imperial curriculum. In a discussion on eclipse calculations, he wrote:

> All the calendars of previous dynasties have calculated the eclipses throughout the year. When they tested the proximity and distance (*shumi*) of their calculations, the old methods were coarse and distant (*cushu*). Sometimes when they predicted an eclipse, there was no eclipse. Sometimes when there was an eclipse, they miscalculated. Sometimes there was an eclipse, but it occurred outside of the new moon…Only our dynasty has surpassed the ancients. The *Yuding lixiang kaocheng* with all of its supplements and additions has added fineness (*jing*) to prediction. When we below investigate predicted times against the observed times of the eclipse above, the times do not vary even a smidgen (lit. do not vary by a thin hair).
>
> 前代各曆，皆以上推春秋日食，驗其疏密，古法牴疏，有當食不食者，有食而失推者，有食不在朔者…惟我朝曆法遠超前代，御定曆象考成上下編後編，屬測加精，以推交食，上考下求，不爽毫髮[20]

Such confidence in the techniques used by the court astronomers meant that the practice of precision was also a political and bureaucratic performance. Astronomers submitted data in advance of an eclipse. Then, they were supposed to conduct observations of the eclipse and report their observations. The astronomers had to check predicted times against observed times. Because missionaries also published their data through European scientific societies, historians have compared the various datasets and determined that Chinese astronomers reported data based on

[19] Yunli Shi, "Eclipse Observations Made by Jesuit Astronomers in China: A Reconsideration," *Journal for the History of Astronomy* 31 (2000): 139-140.; Lingfeng Lü, "Eclipses and the Victory of European Astronomy in China," *East Asian Science, Technology, and Medicine* 27 (2007): 139-140.
[20] Zuonan 張作楠 Zhang, *Jiao Shi Xi Cao 交食細草*, CWSFSX (1824). 1b

habit and politics. During moments of revision, when the astronomers were scrutinized for producing new constants and updating different figures, court astronomers reported reliable information. But in other years, they were inconsistent in whether they reported the actual observed data or if they simply copied the prediction as the reported observation. By the late eighteenth century, much of the data even appeared to be copied from nautical almanacs in both prediction and observation.[21]

Did this mean that Chinese astronomers only used precision as a rhetorical strategy and political performance rather than observational practice? It is difficult to say this was a wholesale performance. The bureaucratic context of astronomy certainly had an impact, but precision was also a part of training and education. It was a part of the historical identity of astronomers. For instance, because court astronomers were involved in mapmaking as well as timekeeping, they were taught how to use clocks to measure longitudes with accuracy and precision. These practices were first introduced in the late Ming as a part of the astronomical reform projects. In the late seventeenth century, the French Jesuits came to China and brought pendulum clocks intended for precise measurement as well.[22] These missionary-scientists trained court astronomers to use these tools. During the survey projects of the Kangxi and Qianlong eras, astronomers used clocks for longitudes.[23] Although clocks did not make a major appearance in later data, the knowledge for how to use clocks for this purpose remained a part of institutional training and curriculum.[24]

Mathematicians and astronomers would have also been exposed to several new instruments due to their contacts with missionaries. For instance, the German Jesuit Augustin Hallerstein (1703-1774) became the imperial astronomer in the eighteenth century. He used a basic set-up of telescopes, micrometers, pendulums, and transit instruments in his observational practice. His instruments were not at the cutting-edge of precision, but they were fundamental for making some observations. He conducted observations from the mission college as well as the Beijing observatory. Hallerstein reported some data that specifically mentioned observations at the Beijing

[21] Shi, "Eclipse Observations Made by Jesuit Astronomers in China: A Reconsideration"
[22] Ferdinand Verbiest, *Letters of a Peking Jesuit: The Correspondence of Ferdinand Verbiest SJ (1623-1688)*, ed. Noël Golvers (Ferdinand Verbiest Institute, 2017). 747
[23] Henri Cordier, "Mélanges Géographiques et Historiques. Manuscrit Inédit Du Père A. Gaubil S.J.," *T'oung Pao* 16, no. 4 (1915): 529, 534.; Mario Cams, "Converging Interests and Scientific Circulation between Paris and Beijing (1685-1735): The Path towards a New Qing Cartographic Practice," *Revue d'histoire Des Sciences* 70, no. 1 (2017): 69-70.
[24] Anonymous, *Li Zhi 歷誌*, XXSKQS, vol. 1037 (n.d.). j. 4, 547-549 ; Anonymous, *Li Zhi 歷誌*, XXSKQS, vol. 1038 (n.d.). j. 8, 188-192

observatory. Since lunar eclipses were public events, he would have relied on student astronomers as assistants.[25] Plus, even though there were restrictions on who had access to mission sites, visitors did go to these churches to learn about instruments.

Similarly, when the Portuguese missionary and astronomer Alexandre Gouveia (1751-1808) prepared to take over the position of mathematician and imperial astronomer, he petitioned for multiple precision instruments for his use which were supposed to come via London. These instruments included materials necessary for conducting precision measurement, such as pendulums and even astronomical clocks. He also asked for recent publications of nautical almanacs to take with him.[26]

What then were the consequences of these values? On the one hand, court astronomers became entangled with bureaucratic concerns. The copying of data was a symptom of other institutional breakdowns. By the late eighteenth and early nineteenth century, kinship networks had largely circumvented rigorous mathematical training, and the skills of astronomers declined. Only in the late Jiaqing and Daoguang periods did the government try to reform the institution and improve the skills of the mathematicians and astronomers involved in the office.[27] Nevertheless, court astronomy at the broader level maintained a set of practices that were treated as precise and reliable measurements. Even if people had lost faith in skills of individual astronomers, they had not lost faith in the methods and practices that had made precision possible. Court astronomers had access to people and things that placed them in a distinct community. These particularities had an impact on people like Zhang Zuonan.

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[25] For descriptions of his instruments, see Augustin Hallerstein, *Observationes Astronomicae Ab Anno 1717 Ad Annum 1752 Pekini Sinarum Factae* (J. Trattnern, 1768). 321-330, 373-382. Some of his observations were also reported in scientific journals. Augustin Hallerstein, "Epistola a Rev. Patre P. Augustino Hallerstein, S. J. M. Collegii Astronomici Pekinensis Praeside, Ad Cromwell Mortimer, M. D. Secret. R. S. Missa, Una Cum Observationibus Cometae Visi Pekini 1748. Novae Constellationis Occultationis Martis et Lunae Dec. 6. 1747. Conjunctionis Martis & Veneris Mense Martio 1748. & Congressus Jovis & Veneris Jan. 1. 1748. Ibidem Quoque Factis," *Philosophical Transactions* 46 (1750 1749): 305–15.; Augustin Hallerstein, "A Letter from Dr. Bevis to Dr. De Castro, F. R. S. Containing Extracts of Father Augustin Hallerstein's Astronomical Observations Made at Pekin in 1744 and 1747," *Philosophical Transactions* 47 (1752 1751): 376–84.; Augustin Hallerstein, "A Letter from the Reverend Father Augustin Hallerstein, of the Society of Jesus, President of the Astronomical College at Pekin in China, to Dr. Mortimer," *Philosophical Transactions* 47 (1752 1751): 319–23.

[26] "Lista de Instrumentos de Observação e Estudo Astronómico Pedidos Pelo Bispo Eleito de Pequim, D. Alexandre Gouveia," Letter from Alexandre Gouveia, Arquivo Histórico Ultramarino, 1783, CU/062/0014/00052.; António Graça de Abreu, *D. Frei Alexandre de Gouveia, Bispo de Pequim (1751-1808) Contribuição Para o Estudo Das Relações Entre Portugal e a China* (Centro de Estudos dos Povos e Culturas de Expressão Portuguesa da Universidade Católica Portuguesa, 2004). 40-41

[27] Chang, *The Chinese Astronomical Bureau, 1620-1850*. 182-199

Precision in Philology

Another discipline that impacted values of precision was the study of texts. Classical scholarship transformed in the Qing. From the eighteenth to nineteenth century, scholars revised their understanding of ancient texts by employing new techniques variously called *kaozheng* and *kaoju* i.e. evidential study, to evaluate the transmission of classical knowledge over time.[28] These techniques included specialized fields like historical phonology. They also encompassed other sources of evidence like epigraphy, archaeology, and mathematics. When scholars evaluated texts, they debated ancient sources through the study of facts. Rather than accepting a text's historicity or veracity based on tradition alone, classical scholars constructed material and textual arguments to support their claims. The *kaozheng* movement had a major impact on all classical scholarship. This was firstly because it was associated with academies and family lineages of learning. Secondly, the movement had a vast impact because the promoters started to work in the capital and incorporated *kaozheng* practices within the imperial examinations.[29] *Kaozheng* scholarship had an important effect on the theories of knowledge. The practices could even destabilize the trust in ancient texts. In one of the more radical cases, the historian and philologist Zhang Xuecheng 章學誠 (1738-1801) wrote "The Six Classics are all Histories."[30]

Kaozheng methods influenced the values of precision in terms of careful analysis, technical expertise, and specialization. There was no predetermined curriculum for the study of philology, because scholarship remained heavily enmeshed in local lineages. Nevertheless, the scholar Dai Zhen 戴震 (1724-1777) composed an outline of technical learning that can serve as a model. He shared it in a letter, but his ideas had a broader influence on the schools of scholarship, especially those associated with Suzhou and Changzhou. Dai Zhen claimed that "small studies" (*xiaoxue* 小學) , which included phonology and mathematics, could be practiced as specialties for different books in the classical canon. Studies of the *Canon of Yao* benefited from astronomical knowledge.

[28] For overviews of the *kaozheng* movement, see Elman, *From Philosophy to Philology*. ; Rongjin 葛荣晋 Ge, ed., *Zhongguo Shi Xue Si Xiang Shi 中國實學思想史*, vol. 2 (Shou du shi fan da xue chu ban she, 1994).576-636; Ori Sela, *China's Philological Turn: Scholars, Textualism, and the Dao in the Eighteenth Century* (Columbia University Press, 2018).

[29] Benjamin A. Elman, *Civil Examinations and Meritocracy in Late Imperial China* (Harvard University Press, 2013). 277-279

[30] Cited in Elman, *Civil Examinations and Meritocracy in Late Imperial China*. 273. For an analysis of Zhang's thought, see David S. Nivison, *The Life and Thought of Chang Hsueh-Ch'eng (1738-1801)* (Stanford University Press, 1966).

Studies of the *Book of Poetry* benefited from historical phonology and natural studies. The classics on ritual and technology benefitted from understanding craftsmanship and geometry. In sum, classical texts required specialized technical training.[31]

These new practices had immediate consequences in the discovery of texts. This was most significant in the case of Chinese mathematics. During the Tang dynasty, the state had compiled a set of ten mathematical canons. These ten works became the basis for the mathematical curriculum, but only some of these texts had survived by the Qing dynasty. During the compilation of the *Siku quanshu* project, however, the editors read the Ming dynasty's *Yongle dadian* and discovered manuscript editions of these lost works. From the 1770s to the 1790s, this precise editorial work recovered these classical works and made them available through edited volumes which enabled scholars to engage in new studies about Chinese mathematics.[32] These discoveries were not limited to ancient classics. Similar editorial projects led to the discovery of forgotten commentaries and publications on mathematics from the Song and Yuan periods. These works showed independent methods for solving unknowns compared to the methods most practiced from the West.[33] These autochthonous methods, which included *tianyuan* 天元 "Method of Celestial Origin" and *siyuan* 四元 "Four Origin Method", were algorithms for solving algebraic problems.[34] This scholarship stimulated studies in native mathematics and led to a new community that tried to investigate native mathematics as a scholarly project in addition to the more bureaucratic-oriented mathematics of the Astronomical Bureau.

Philological research and technical training created precise approaches towards classical knowledge in geography and astronomy. Qi Shaonan 齊召南 (1706-1768), who was an influential scholar in the Hanlin Academy and involved in the compilation of the imperial gazetteer, studied

[31] Zhen 戴震 Dai, *Dai Zhen Quan Shu 戴震全書*, vol. 6 (Huangshan shushe, 2010). j. 32, 368-369; Minghui Hu, *China's Transition to Modernity: The New Classical Vision of Dai Zhen* (University of Washington Press, 2015). 69-70

[32] Elman, *On Their Own Terms: Science in China 1550-1900*.245-250; Li and Du, *Chinese Mathematics: A Concise History*.225-230

[33] See, for example, Jean-Claude Martzloff, *A History of Chinese Mathematics* (Springer, 2006). 104-105; Manfred Friedsam, "Les Mathématiques Chinoises Des Song et Des Yuan Dans Leur Contexte Socio-Culturel" (Phd Dissertation, Institut national des langues et civilisations orientales, 1999 ; Ulrich Libbrecht, *Chinese Mathematics in the Thirteenth Century: The Shu-Shu Chiu-Chang of Ch'in Chiu-Shao* (MIT Press, 1973).

[34] Li and Du, *Chinese Mathematics: A Concise History*.135-148; Martzloff, *A History of Chinese Mathematics*.258-271; Tian, "Jiegenfang, Tianyuan, and Daishu: Algebra in Qing China."106-112;).; Tian Miao, "Si Yuan Yu Jian de Qing Dai Ban Ben Ji Jia Ling Si Cao de Jiao Kan Yan Jiu 四元玉鑒的清代版本及假令四草的校勘研究," *Ziran Kexue Shi Yanjiu* 18, no. 1 (1999): 36–47.

historical geography. He used precision measurement to correct maps. He published higher quality data about counties and used this data to study changes over time. Qi was able to achieve this new level of precision because he had access to the new maps produced during the imperial survey projects. Although Qi did not publish his data in a specific list, he used the data as a way to create detailed studies of waterworks, river networks, and the changes in the landscape.[35] The scholar Ruan Yuan 阮元 (1764-1849), who became the exemplar for sponsoring mathematical and astronomical training in the Jiaqing and Daoguang periods, first gained notoriety in the metropolitan examination because he applied careful measurement to classical sources. By relying on the eclipse techniques of the Qing calendar, Ruan Yuan reconstructed a new date for the eclipse mentioned in a poem from the *Book of Poetry*. He challenged the interpretations used by scholars of the Song commentaries and supported the Han period commentaries on the text.[36]

By the early nineteenth century, the intellectual debate had shifted from texts to morals. Although the methods became increasingly prominent in classical scholarship, there were many critics who suggested that its focus on technical expertise lost the purpose of moral training. This debate has been characterized as disagreements over Han versus Song commentaries.[37] Nevertheless, because *kaozheng* methodology had introduced new levels of precision to the study of classical texts, even detractors, who argued that Han Learning scholars had rejected the moral frameworks from Cheng-Zhu orthodoxy, engaged in precision analysis of classical texts founded on technical training in specialized disciplines. While the moral justification for precision came

[35] Xue Zhang, "The Plurality of Reception: Latitude and Longitude in Early Modern China, 1700–1900," *Isis* 113, no. 3 (2022): 537–58. 546-550; Jiajing Zhang, "From Fenye to Latitude and Longitude: The Adjustment and Renewal of the Positioning System in Chinese Local Gazetteers during Qing Dynasty," *Journal of HIstory of Science and Technology* 18, no. 1 (2024): 86–114. 106

[36] Ruan Yuan, *Yan Jing Shi Ji 揅經室集*, vol. 1 (Zhonghua shu ju, 1993). j. 4, 11a-13b, 91-100. In 1791, the Qianlong Emperor raised Ruan Yuan to the highest position on account of his scholarship. The emperor considered his work to be of the highest caliber, and his classical studies were then circulated. Betty Peh-T'i Wei, *Ruan Yuan, 1764-1849: The Life and Work of a Major Scholar-Official in Nineteenth-Century China before the Opium War* (Hong Kong University Press, 2006). 56-57. For additional context about this particular debate, see Yingtian He, "Well-Ordered Textures: The Book of Odes and the Study of Wu in Mid-Qing China" (Phd Dissertation, Princeton University, 2023). 365-367

[37] For additional context on Han versus Song Learning, see Fung, *A History of Chinese Philosophy*, vol. 2.630-672; Benjamin A. Elman, "Philosophy (I-Li) versus Philology (K'ao-Cheng): The Jen-Hsin Tao-Hsin Debate," *T'oung Pao* 69, nos. 4–5 (1983): 175–222.; Ying-shih Yu, "Some Preliminary Observations on the Rise of Qing Confucian Intellectualism," in *Chinese History and Culture: Seventeenth Century Through Twentieth Century*, vol. 2, by Ying-shih Yu, ed. Josephine Chiu-Duke and Michael S. Duke (Columbia University Press, 2016); Ying-shih Yu, "Dai Zhen's Choice between Philosophy and Philology," in *Chinese History and Culture: Seventeenth Century Through Twentieth Century*, vol. 2, by Ying-shih Yu, ed. Josephine Chiu-Duke and Michael S. Duke (Columbia University Press, 2016).

under criticism, the actual value of precision characterized traditional scholarship and studies of the classics in preparation for the imperial examinations.

3.2 Astronomical Tools

These values of precision had a direct impact on shaping Zhang Zuonan's vision of scholarship and public service in the early nineteenth century. As a native of Jinhua 金華 prefecture, Zhang Zuonan came from a prosperous gentry family and aspired to a traditional career pathway for someone of his status. He tried to secure a position in the imperial bureaucracy. To that end, he specialized in the study of classical poetry and took the examinations. In 1796, he passed the *juren* exam in Hangzhou, and then in 1808, he finally passed the *jinshi* examination in Beijing, after several failed attempts.[38]

When Zhang Zuonan started preparing for the provincial and metropolitan examinations, he started to use mathematics and astronomy as his entry point into the philology movement. According to Zhang's own writings, he read about Ruan Yuan's winning examination essay that used the imperial calendar to reconstruct historical chronology, and he was inspired to do the same.[39] He sought out the imperial textbooks and eventually purchased his own copies. Zhang also wrote that he initially had difficulty in studying this work on his own. Although he never explicitly claimed that he studied with the astronomical bureau, Zhang's later research suggests that he had some experience working with the Astronomical Bureau. This would have been possible, because the Hanlin academy permitted students who were preparing for the metropolitan exam to take classes in the Hanlin academy as apprentices. They were not formal students in the mathematics academy, but they could listen to lectures.[40]

Regardless, by the time that Zhang had become a *jinshi*, he had gained a thorough understanding of imperial mathematics. He started to apply that knowledge in teaching other scholars preparing for exams and studying classical texts. He worked on a classical project studying historical chronology, and he started to publish practical explanations about how to do this work.[41] Even though Zhang did not claim to be an astronomer, he was enamored with

[38] Zhang, *Zhang Zuonan Nianpu*. 21-22, 57-79
[39] Zhang, *Zhang Zuonan Nianpu*. 21-22
[40] Chang, *The Chinese Astronomical Bureau, 1620-1850*. 153-154
[41] Zhang Zuonan, *Mei Yi Sui Bi 梅簃随笔* (Zhejiang gu ji chu ban she, 2013). 57

astronomical methods which he believed could become useful with the proper formation. There are four ways that we can understand how Zhang used his knowledge of astronomical and mathematical practices of precision to advocate for practical benefits of using this form of precision. Zhang emphasized using instruments around logarithms, sectors, magnetism, and portable sundials.

Logarithms

According to his own admission, Zhang was initially skeptical about adopting astronomical practices for public timekeeping. The calculations seemed arduous. As he explained in one of his prefaces, when he visited Beijing during his examination years, he could not afford to buy a mechanical clock.[42] Since he was unable to use clocks to help him measure local times, he turned instead to a computational solution called the "method of suspending arcs" *chuihu* 垂弧. This was an algorithm in spherical trigonometry that divided spherical triangles into two right triangles so that one could apply trigonometric functions to find more precise measures of arc. Nevertheless, it was calculation heavy and it required access to trigonometric tables.[43] Over the years, he kept using the method to find local times as he moved to new government positions. For instance, in 1813, when he became the educational commissioner in Chuzhou 處州, he used the method. He used it again when he became the magistrate of Changzhou.[44] Yet the calculations were hard. "This method of verifying calculation through checking tables changed in relation to the time of the year and for every degree difference in latitude," he said. "Moreover, one must carry [the tables] all in one's baggage. It's like throwing gold pieces into a ravine, a useless waste."[45]

Logarithms solved this problem. Logarithms, invented by John Napier and then expanded by Henry Briggs in the early seventeenth century, had been known to Chinese astronomers and mathematicians since at least the late Ming period, not long after their elaboration in England and

[42] 曩在京師力不能置鐘表. Zhang Zuonan, *Gao Hu Xi Cao 高弧細草* (1821). Zhang Zuonan preface, 1a

[43] 因用垂弧本法逐節氣時刻求太陽距地高度並用正切餘切比例加減太陽半徑求橫直表景長短. Zhang, *Gao Hu Xi Cao*. Zhang Zuonan preface, 1a. For more information on this method, see Jiang-Ping Jeff Chen, "The Evolution of Transformation Media in Spherical Trigonometry in 17th- and 18th-Century China, and Its Relation to 'Western Learning,'" *Historia Mathematica* 37, no. 1 (2010): 99, note 118.

[44] Zhang, *Gao Hu Xi Cao*. Zhang Zuonan preface, 1a.

[45] 然依法推步每度動經旬月及更曆一地又須零衍存之行篋幾等黃金擲虛牝矣. Zhang, Gao Hu Xi Cao. Zhang Zuonan preface, 1a-1b

France.[46] Logarithms were called *duishu* 對數 in Chinese. The Polish Jesuit Johannes Nikolaus Smogulecki (1610-1656) collaborated with an astronomer and astrologer Xue Fengzuo 薛鳳祚 (1599-1680) to translate some of the tables into Chinese.[47] Over the years, logarithms continued to have a place in imperial mathematics. They were included in the imperial curriculum, and they were used in several other mathematical sources in the eighteenth-century.[48] Court astronomers used them to handle some of their tasks in computation.[49] In those contexts, though, one tended to focus only on the role of logarithms in substituting arithmetic operations, rather than their use in constructing tables and in handling complex problems with a series. Nevertheless, this began to change in the second half of the eighteenth century as a variety of court astronomers became involved in trying to create trigonometric tables and recursive problems centered around working with power series. This brought about new interests in logarithms within the Western mathematics communities and led to a variety of private manuscripts that were accessible only in Beijing.[50]

These applications of logarithms for working with a series were not well-known for a variety of reasons. Although the Mongolian astronomer Minggatu 明安圖 (1692-1763) worked on his own recursive methods in the mid-eighteenth century, his work was not published until the 1820s.[51] Most Jiangnan scholars by contrast prioritized the study of the Chinese mathematical tradition more than exploring recursion. Even those otherwise known for their creative integrations of techniques preferred to use the proportional methods of algebra rather than the transformations associated with logarithms. Wang Lai, for example, was one of the students who trained in the

[46] John Napier, *Mirifici Logarithmorum Canonis Descriptio* (Ex officina A. Hart, 1614).; Henry Briggs, *Arithmetica Logarithimica* (Gulielmus, 1624).; Henry Briggs, *Trigonometria Britannica* (P. Rammasenius, 1633).; Adriaan Vlacq, *Arithmetica Logarithmica* (P. Rammasenius, 1628).; Adriaan Vlacq, *Trigonometria Artificialis* (P. Rammasenius, 1633). For a recent history on the invention of logarithms and various innovations in calculating technique, see Julian Havil, *John Napier: Life, Logarithms, and Legacy* (Princeton University Press, 2014).
[47] Xue Fengzuo, *Li Xue Hui Tong Zheng Ji 歷學會通正集*, Zhongguo Kexue Jishu Dianji Tonghui 11 (Henan jiaoyu chuban she, 1993). j. 12, 872-893; Li and Du, *Chinese Mathematics: A Concise History*. 208-209; Denis Roegel, "Vlacq's Tables in Chinese: Introduction to Chinese and Japanese Tables of Logarithms, with a Review of Secondary Sources," White Paper, Locomat Project, 2011, https://inria.hal.science/hal-00654438/PDF/clogdoc.pdf. 1
[48] Jami, *The Emperor's New Mathematics*. 297-299
[49] Li, "Template Tables and Computational Practices in Early Modern Chinese Calendric Astronomy."
[50] Li and Du, *Chinese Mathematics: A Concise History*. 234-240; Jiang-Ping Jeff Chen, "Trigonometric Tables: Explicating Their Construction Principles in China," *Archive for the History of Exact Sciences* 69 (2015): 491–536. 491-536; Jami, *Les Méthodes Rapides Pour La Trigonométrie et Le Rapport Précis Du Cercle*.
[51] Jami, *Les Méthodes Rapides Pour La Trigonométrie et Le Rapport Précis Du Cercle*. 178-180

Astronomical Bureau and who was familiar with Western methods.[52] He used logarithms for some of his work, but he rejected their use for the "complete comparison method" *zongjiao fa* 總較法, a set of procedures that related to proportions inside proportions. Wang Lai claimed that only algebraic or representational methods resolved these problems effectively.[53]

So, while familiar with the concept of logarithms for many years, Zhang only started to grasp their efficiency on account of Jiang Lintai joining his staff around 1820. Prior to this, Jiang had been working for Qi Yanhuai in Jinkui 金匱 county, a neighboring district to Yanghu.[54] According to Qi's account, Qi himself had read Wang Lai's manuscript, likely around 1810 to 1812, when they were both in Beijing. Qi recalled that when he had first read that Wang preferred to use root extraction for "complete comparison" problems instead of logarithms, Qi had doubted Wang Lai's claim, yet Qi was unsure how to make it work.[55] Then, when Qi came to Jinkui and started running the government office, he brought Jiang Lintai on to his staff to practice spherical trigonometry and help him with calculation. He noticed that Jiang could solve problems faster due to his ability to use logarithms creatively. "I was amazed at the ingenuity in the Western practice of using logarithms [to make multiplication easier]," he wrote.[56] Qi asked Jiang to write an explanation for his own application of logarithms. "With his explanations, my confusion melted like ice, and I became all the more convinced that Jiang Lintai had a truly penetrating understanding in these matters."[57]

Between 1818 and 1819, Qi and Jiang started working on a draft about logarithms and spherical trigonometry. However, this remained a private endeavor through 1820. Then, because of Zhang's efforts and interests, and because Qi needed to retire for personal health reasons, Qi recommended Jiang to Zhang Zuonan. He suggested Jiang could support Zhang with carrying out astronomical tasks as well as calculation, but Qi did not mention Jiang's proficiency in logarithms. Consequently, when Zhang Zuonan subsequently asked Jiang to help him compile new latitude

[52] Horng Wann-Sheng, "Chinese Mathematics at the Turn of the 19th Century: Jiao Xun, Wang Lai and Li Rui," in *Philosophy and Conceptual History of Science in Taiwan*, ed. Cheng-hung Lin and Daiwei Fu (Kluwer Academic Publishers, 1993).169

[53] Wang Lai, *Heng Zhai Suan Xue 衡齋算學*, Xuxiu Siku Quanshu 續修四庫全書 1045 (1854). Wang Lai preface, 1a, 477

[54] *Chonglu Qi Shi Zu Pu 翀麓齊氏族譜*, Microfilm (Family History Library, 2003). j. 8, 60a-60b; Kebao 諸可寶 Zhu, *Chou Ren Zhuan San Bian 疇人傳三編*, vol. 516, Xuxiu Siku Quanshu 續修四庫全書 (1888). j. 2, 7a-7b, 543

[55] Zuonan 張作楠 Zhang, *Hu Jiao She Ru 弧角設如*, CWSFSX (1821). Qi Yanhuai preface, 1a

[56] Zhang, *Hu Jiao She Ru*. Qi Yanhuai preface, 1a

[57] 予渙然冰釋益信雲樵於此事真能貫通. Zhang, *Hu Jiao She Ru*. Qi Yanhuai preface, 1a

and dial tables that he wanted for times in Changzhou, the new staffer apparently completed it in a few days. This was a big surprise to Zhang, because Zhang had previously taken much longer to do it on his own. When asked how he performed these trigonometric calculations so quickly, Jiang explained that he was using a different set of algorithms, which he called the "the simple method with logarithms" *duishu jianfa* 對數簡法.[58]

Having discovered an efficient approach to generating tables, Zhang then collaborated with Jiang Lintai to compose a new treatise that explained how to use these logarithms and create shortcuts in the calculations with trigonometric ratios. Zhang recognized that more data did not necessarily improve errors, but faster methods helped reduce the workload.[59] By combining sines and cosines, the calculator could set up several proportions that enabled the user to quickly determine angular heights. To find the height,

> One does not need to add, subtract, and divide, nor search the table of sines and cosines to encounter the celestial degree. If one has remainder units, or the seasonal joints and division into the hou, they can all follow this method and set up the ratios. In finding ratios and in the method for finding the celestial degree, there is nothing simpler.
>
> 既不須加減折半，又省檢正餘弦表遇高度，有零分或節氣分三侯，俱可依此法，衍成定率，求之，求高弧法，莫此為簡. [60]

Logarithms decreased the number of steps, and they offered a transformation to addition and subtraction instead of using multiplication methods. These were all simpler modes of processing. Hence, one could then create more detailed sets of data for smaller units of time, even creating distributions of time scales that were defined by the *hou* 候, that is the shorter fractions of the solar year beyond the use of the twenty-four seasonal qi.

---

[58] 簿書鮮暇屬江雲樵補之不旬而就詫而叩其術則所創對數簡法也. Zhang, *Gao Hu Xi Cao*. Zhang Zuonan preface, 1b

[59] Zhang, Gao Hu Xi Cao. Zhang Zuonan preface, 2a. For instance, Zhang had read one of Mei Wending's studies on data quality. Mei had originally thought that he could revise astronomical constants because he had access to data collected in mosques as well as the data that was brought by the Jesuits. But when Mei tried to integrate these independent sources of information he saw that the data contained wide levels of error and variation. Data collection was therefore not a solution on its own for resolving debates about astronomical measurement and prediction. Mei Wending, *Li Suan Quan Shu 歷算全書*, SKQS (1726). j. 19, 16a-21b

[60] Zhang, *Gao Hu Xi Cao*. 19a

Logarithms provided efficiency. Calculation was itself a time-constrained, labor-intensive task. If one increased the amount of data, it increased the time. [61] More data allowed more precision and verification. But it also had a trade-off in terms of work and time. For government officials like Zhang Zuonan, efficiency mattered when dealing with these problems of precision. Because he was aware that the times of county districts differed by varying degrees from prefectures and provinces, he knew that official data was not accurate for precise timekeeping. He had therefore only limited his efforts to the places where he himself was located. His first attempts had only created tables based on the units of hours following the earlier models by Mei Wending. That was hard enough. "I truly suffered from the complexity," he wrote.[62] After he learned about logarithms, Zhang realized that he could produce different types of latitude tables and timetables for all locations in the empire quickly.

> We can indeed say that using logarithms is superior! We could use this method and then supplement calculations for every province. We can perform calculations in a day and complete it. Is this a not a fast method? Yet with this method, anyone can do calculations. Any place can follow its principles. So, since every province can be done easily, why would we not supplement them for even more places?
>
> 又不須檢正餘弦表，可謂善用對數矣。得此法而補成各省細草，計日可成，豈非快事，然得此法，而人人可算，處處可推，即今所衍各草，尚可不存，又何須再補哉[63]

[61] Compare this notion of labor time in calculation with the role of computers in the Greenwich Observatory. Since the primary task of the observatory was the production of almanac data, the computers who compiled the data into the ephemerides were also involved in trying to identify techniques for making calculation more efficient. Logarithms were also used in this context, and they were coded as tools rather than as scientific instruments, because of the status difference between the astronomer and the computer. Automated calculation machines like Babbage's machines were initially designed in order to deal with the increasing amounts of data necessary for astronomical calculation that needed to be compiled into annual calendars for observatories, the navy, and other audiences. Simon Schaffer, "Astronomers Mark Time: Discipline and the Personal Equation," *Science in Context* 2, no. 1 (1988): 115–45.; Simon Schaffer, "Babbage's Intelligence: Calculating Engines and the Factory System," *Critical Inquiry* 21, no. 1 (1994): 203–27.; David Aubin, "On the Epistemic and Social Foundations of Mathematics as Tool and Instrument in Observatories, 1793–1846," in *Mathematics as a Tool: Tracing New Roles of Mathematics in the Sciences*, ed. Johannes Lenhard and Martin Carrier (Springer Cham, 2017).

[62] 誠苦其繁也. Zhang, *Gao Hu Xi Cao*. Zhang Zuonan preface, 2a

[63] Zhang, *Gao Hu Xi Cao*. Zhang Zuonan preface, 2a

Logarithms improved speed and the quality of the data. Since one could then capture more data, Zhang believed that it was possible to now make it even more detailed for everyone. Space was no longer a constraint.

Zhang applied these principles to create new artifacts that allowed people to scan and view time and geography. One of the results of this publication was the production of multiple sets of data tables that incorporated latitudes so that users could identify local time and measure that local hour with greater precision and detail imitating some of the practices associated with the astronomers in Beijing. First, Zhang and his collaborators created a handbook on dialing that they called *Chuaiyue xiaolu* 揣籥小錄 "A small treatise on harmonic measurement", with the rare phrase *chuaiyue* alluding to the Han dynasty terms for tools of measurement. The book outlined the methods for building vertical and horizontal sundials. This manual introduced the techniques and instruments that were relevant for how to build dials such that they incorporated latitude and ensured that the dial instrument pointed to local times.

Then, in a second volume to the handbook, the collaborators introduced latitude-informed data to supplement and apply these tools for more precise guides for finding time. The first table, for instance, was called the "Table of Northern Latitudes" (see Figure 3-2). The table was not just a list of locations with their latitude coordinates. The table applied solar time measurements for northern latitudes ranging from 18 to 55 degrees. The upper and bottom rows depicted the hours of the day. Beneath the time reference, the table labeled the angular height of the sun above the horizon in degrees and minutes. For a particular 15-day period in the year, one could check the position of the sun in degrees and know the respective time. Similarly, if one knew the hour, one could then use the table to collect the sun's altitude data.[64] Although this data was applied to ranges, this data offered a more granular approach to local time by providing time units for every latitude related to the Qing empire.

[64] Zhang Zuonan, *Chuai Yue Xu Lu 揣籥續錄*, CWSFSX (1820). j. shang, 4b

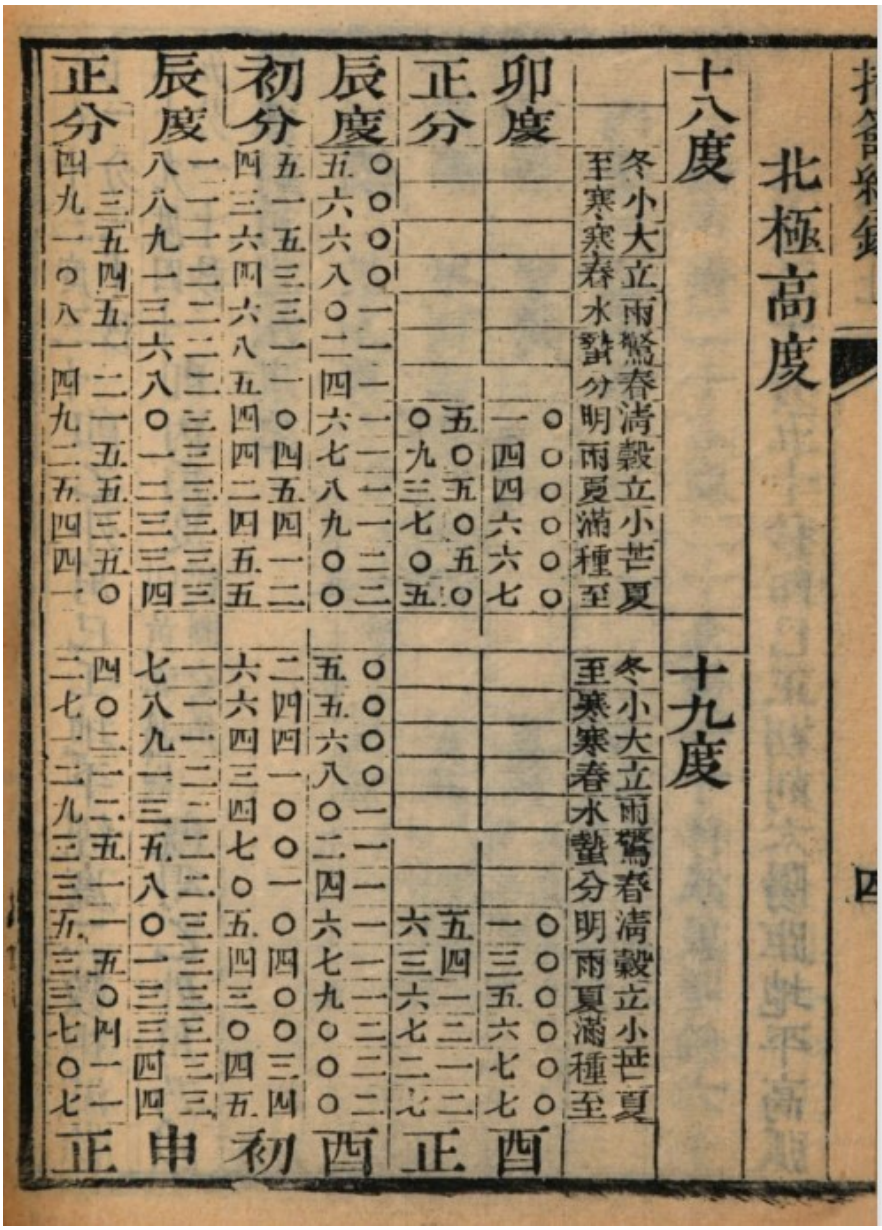

Figure 3-2: Image of the Table of Northern Latitudes. Source: Zhang Zuonan, *Chuiyue xulu*, j. shang, 4b

Table 3-1: Table of Northern Latitudes Translation. Note that the hours are meant to be reciprocal on the top and bottom. Source: Author translation, Zhang Zuonan, *Chuiyue xulu*, j. shang, 4b

Chen zheng (8 am)		Chen chu (7 am)		Mao zheng (6 am)			18 Degrees	Northern Latitude
Fen-minute degree	Du-degree	Fen-minute degree	Du-degree	Fen-minute degree	Du-degree			
14	18	54	5			Winter solstice (Dongzhi)		
39	18	13	6			Small cold (Xiaohan)		
51	19	56	6			Large cold (Dahan)		
40	21	43	8			Establishing Spring (Lichun)		
58	23	36	10			Rainy waters (Yushui)		
11	26	18	12			Insects awaken (Jingzhe)		
24	28	15	14			Spring equinox (Chunfen)		
19	30	4	16	50	1	Pure brightness (Qingming)		
52	31	44	17	9	4	Grain rain (Guyu)		
55	32	52	18	53	4	Establishing Summer (Lixia)		
34	33	44	19	7	6	Small buds (Xiaoman)		
54	33	15	20	50	6	Full harvets (Mangzhong)		
1	34	25	20	5	7	Summer solstice (Xiazhi)		
42	17	26	5			Winter solstice (Dongzhi)	19 Degrees	
7	18	46	5			Small cold (Xiaohan)		
21	19	44	6			Large cold (Dahan)		
12	21	13	8			Establishing Spring (Lichun)		
29	23	4	10			Rainy waters (Yushui)		
53	25	7	12			Insects awaken (Jingzhe)		
13	28	10	14			Spring equinox (Chunfen)		
15	30	5	16	56	1	Pure brightness (Qingming)		
53	31	44	17	43	3	Grain rain (Guyu)		
3	33	3	19	16	5	Establishing Summer (Lixia)		
47	33	0	20	27	6	Small buds (Xiaoman)		
10	34	34	20	12	7	Full harvets (Mangzhong)		
17	34	45	20	27	7	Summer solstice (Xiazhi)		
Shen zheng (5 pm)		You chu (6 pm)		You zheng (7 pm)				

In 1821, the group published even more elaborate tables. These new tables combined multiple sets of information to guide the user in using instruments, measuring the lengths of shadows, and then determining particular times. These new tables (see Figure 3-3) were meant to be even more precise, because they intended local gentry to use the data for conducting rituals.[65] They, therefore, prepared a set of worked out problems or *xicao* 細草 so that individuals would know how to use the different required measurements. Then, they prepared short pamphlets which included printed sets of tables with information and data at a higher resolution than almost any previous public information. These tables included the following sets of information at higher resolutions: 1) quarter-hours; 2) degrees measured in seconds; 3) rulers for measuring down to thousandth places. Secondly, all the information was then subdivided by the different solar periods, such that a person could conduct coordinate actions and times.[66]

[65] Zhang Zuonan, *Gao Hu Xi Cao 高弧細草* (1821). Zhang Zuonan preface, 1a-2b
[66] Zhang, *Gao Hu Xi Cao*. Si shi du 四十度, 1a-14b

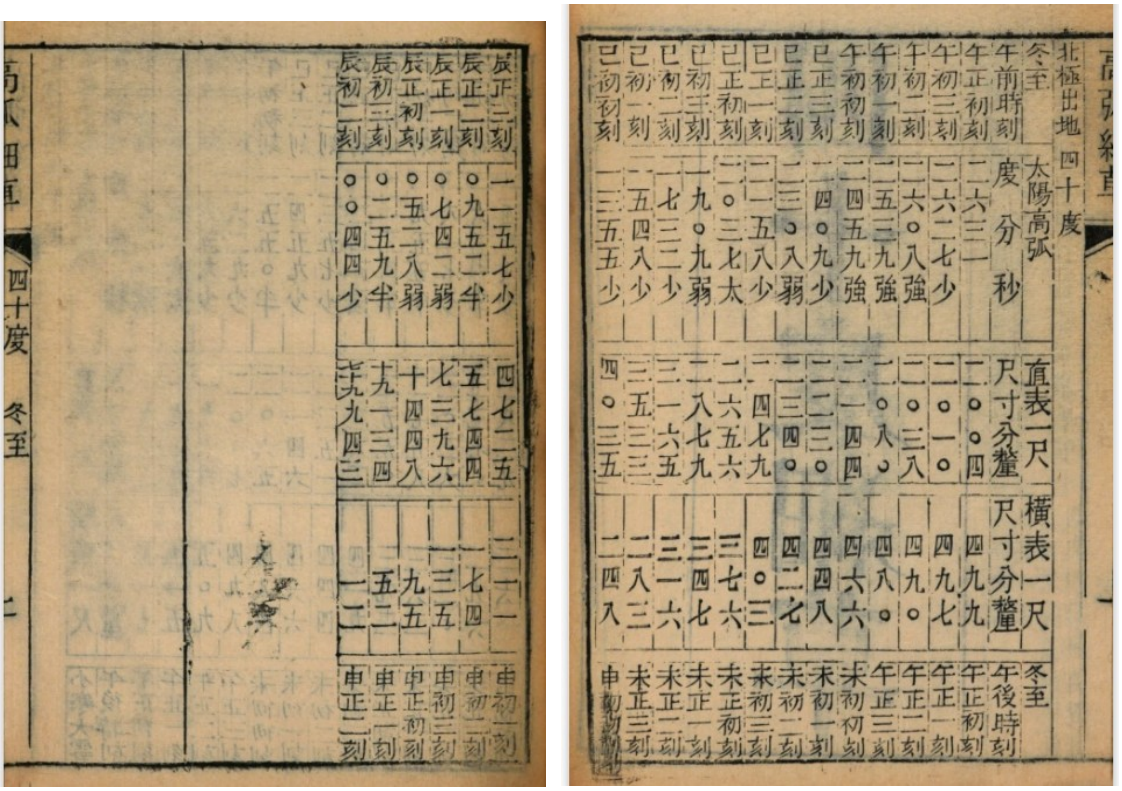

Figure 3-3: Image of Updated Table for Northern Latitudes. This data is calibrated for forty degrees latitude. Source: Zhang Zuonan, Gaohu xicao, 1b-2a

Table 3-2: Translation for the Updated Table for Northern Latitudes. The table can be read from the top right to the left, then from the bottom left to the bottom right. Source: Author Translation, Zhang Zuonan, Gaohu xicao, 1b-2a

Chenchu, second ke	Chenchu, third ke	Chenzheng, chuke	Chenzheng, first ke	Chenzheng, second ke	Chenzheng, third ke	Sichu, chuke	Sichu, first ke	Sichu, second ke	Sichu, third ke	Sizheng, chuke	Sizheng, first ke	Sizheng, second ke	Sizheng, third ke	Wuchu, chuke	Wuchu, first ke	Wuchu, second ke	Wuchu, third ke	Before noon, zheng hour, chuke	Before noon, shike	Winter solstice (Dongzhi)	Northern Latitude 40 degrees
0044 shao (less)	0259 ban (half)	0528 rong (weak)	0742 rong (weak)	0952 ban (half)	1157 shao (less)	1355 shao (less)	1548 shao (less)	2732 shao (less)	2909 rong (weak)	2037 tai (great)	2158 shao (less)	2308 rong (weak)	2409 shao (less)	2459 qiang (strong)	2539 qiang (strong)	2608 qiang (strong)	2627 shao (less)	2631	Degree du Fen-minute Miao-second	Solar Altitude Arc	
79943	19134	10448	7396	5744	4725	4305	3533	3165	2879	2656	2479	2340	2230	2144	2080	2038	2010	2004	Chi-foot Cun-inch Fen-hundredths li-thousandths	Vertical 1-chi foot gnomon	
12	52	95	135	174	211	248	283	316	347	376	403	427	448	466	480	490	497	499	Chi-foot Cun-inch Fen-hundredths li-thousandths	Horizontal 1-chi foot gnomon	
Shenzheng, second ke	Shenzheng, first ke	Shenzheng, chuke	Shenchu, third ke	Shenchu, second ke	Shenchu, first ke	Shenchu, chuke	Weizheng, third ke	Weizheng, second ke	Weizheng, first ke	Weizheng, chuke	Weichu, third ke	Weichu, second ke	Weichu, first ke	Weichu, chuke	Wuzheng, third ke	Wuzheng, second ke	Wuzheng, first ke	Wuzheng, chuke	After noon, shike	Winter solstice (Dongzhi)	

While later authors, such as Alexander Wylie, did not view these tables as particularly original, the tables were creative for everyday users.[67] The tables could be read in a clockwise fashion and reconstructed the circular pattern of a dial. More importantly, the tables offered some of the first public and detailed divisions of astronomical time for readers. In the following decades, these kinds of publications only started to provide more visible awareness concerning precision as they moved ever closer to smaller units of time and measurement that claimed to provide useful knowledge for interested parties.

Sectors

In addition to logarithms, Zhang Zuonan also employed another tool called the sector. It is sometimes confusingly called a proportional compass. This mathematical and calculating instrument relied on the concept of similar triangles to help one conduct basic arithmetic and geometric functions. Similar to a sliding rule, the tool contained proportional lines or rules. It had applications in artillery, surveying, and astronomy. Different sectors started to appear in the late sixteenth century, although the instrument is traditionally associated with Galileo Galilei.[68]

Even more than logarithms, Jesuit missionaries used the sector as a calculating aid for artillery and astronomy. The first book in Chinese about it was published in 1631 titled *Bili guijie* 比例規解 *Explanation on the Proportional Compass*. This sector included ten sets of lines which included arithmetic operations as well as lines related to trigonometry and logarithms.[69] Because of its use in geometry and calculation, it was later incorporated into the collected works for

[67] Alexander Wylie, *Notes on Chinese Literature: With Introductory Remarks on the Progressive Advancement of the Art* (American Presbyterian Mission Press, 1867). 126

[68] James A. Bennett, *The Divided Circle: A History of Instruments for Astronomy, Navigation, and Surveying* (Phaidon-Christie's, 1987). 62-63; Allan Chapman, *Dividing the Circle: The Development of Critical Angular Measurement in Astronomy, 1500-1850* (Ellis Horwood, 1990). 16-33; Stillman Drake, "Galileo and the First Mechanical Computing Device," *Scientific American* 234, no. 4 (1976): 104–13.; Mario Biagioli, "Replicating Mathematical Inventions: Galileo's Compass, Its Instructions, Its Students," *Perspectives on Science* 30, no. 3 (2022): 437–62.

[69] Although Galileo's books were brought to China, Galileo's original sectors did not use ten lines, which suggests that the *Explanation* is not entirely a translation from Galileo but combined elements from later instruments, such as Michel Coignet, *La Geometrie, Redvite En Vne Facile et Briefve Practique Par Deux Excellens Instrumens* (Chez C. Hvlpeav, 1626). For additional details on the compass in China, see Li and Du, *Chinese Mathematics: A Concise History*. 209-211; Yan Dunjie, "Jialilüe de Gong Zuo Zao Qi Zai Zhongguo de Chuan Bu 加利略的工作早期在中國的傳布," *Ke Xue Shi Ji Kan* 7 (1964): 8–27.

calendar reform, the *Chongzhen lishu* 崇禎曆書.[70] Then, in the early Qing, Mei Wending, the mathematician and astronomer most noted for combining Chinese and Western mathematics, further popularized the use of the instrument. When the missionaries had translated the book, they had chosen literal phrasing, but that rendered the terms awkward for Chinese users. Mei changed the translations, which made the instrument much easier to understand.[71] Due to his influence, the tool (see Figure 3-4) was added to the imperial mathematics curriculum in the early eighteenth century as well.[72]



Figure 3-4: Sector from the Palace Museum. The sector dates to the Kangxi period, and it is a product of the imperial workshops. The sector has been engraved with Chinese translations next to earlier inscriptions. In addition to Chinese numerals, the side visible here contains the following lines: 1) 分圓 Divide the Circle; 2) 分面 Divide the Plane; 3) 正弦 Line of Sines; 4) 平分 Arithmetic Line; 5) 球内各體 Structures in the Circle [i.e. Quadrant]. Source: Imperial Workshops, Proportional Compass, Kangxi Reign, Gilt-copper, 33.3 cm x 6.2 cm, Beijing Palace Museum, Clock.

Although this instrument had a variety of different geometric and surveying functions, many of the sector's paradigm problems in the Chinese mathematical literature were about setting up sundials according to different latitude parameters. This was because sundial construction

[70] Yunli Shi and Chu Longfei, eds., *Chongzhen Li Shu He Jiao 崇禎曆書合校*, 2 vols. (Zhongguo kexue jishu daxue chuban she, 2017). Vol. 2, 1743-1762

[71] Mei, *Li Suan Quan Shu*. j. 39

[72] *Yu Zhi Shu Li Jing Yun 御製數理精蘊*, SKQS (1723). Xia bian, j. 40 ; Jami, *The Emperor's New Mathematics*. 193-194, 357-358. Since these sectors could also be used as mathematical drawing instruments, they were also included in the imperial sources related to perspective drawing for imperial artists. For more, see Marco Musillo, *The Shining Inheritance: Italian Painters at the Qing Court, 1699-1812* (Getty Research Institute, 2016). 117-121

combined several teaching functions into a single problem. It encouraged the student to engage with the celestial sphere and geometric models that were fundamental to understanding all other aspects of the new Western geometry centered on the celestial sphere. Furthermore, the tool provided the student with a practical means of learning trigonometric ratios and understanding the rules of proportionality that shaped the transformation of three-dimensions into two-dimensions. Mathematical transpositions involved in orthographic projection were important for astronomical visualizations and cartography. Moerover, because the tool included shortcuts for dealing with arithmetic and geometric progressions, the student equally benefitted from the physical manipulations involved in calculation, namely understanding the geometric positions that helped transform procedures and explain how various number lines related to one another. Whether in formal cases, such as the imperial court astronomy, or in the informal sites of manuscript and practical manuals, the teaching of the sector was inextricably linked to geometric approaches towards making sundials.[73]

These practices informed how Zhang built the two monumental sundials in Changzhou. Each of the monuments contained all the geometric measurements involved in the design process, including the circles and the subsequent divisions of lines to show hours as well as the intersecting lines to show the divisions of the sun's path throughout the year (see Figure 3-5). In his treatises, Zhang explained how to construct both horizontal and vertical sundials by using the sector. Each of the various lines added to the dial plate were based on trigonometric ratios. To increase the subdivisions on the plate and show quarter units instead of just hours, one needed to use the sector to proportionally divide the hours into smaller fractions and add the lines through repetition.[74] In other words, these dials were meant to illustrate finer distinctions in time by the proper location.

[73] For additional examples, see Ye Nong, ed., *Yesu Hui Shi Pangdiwo Zhu Shu Ji 耶穌會士龐迪我著述集* (Guangdong renmin chuban she, 2019). Ri gui tu fa 日晷圖法, 313-392; Lu Zhongyu, *Ri Yue Xing Gui Shi 日月星晷式*, Zhongguo Kexue Jishu Dianji Tonghui 13 (Henan jiaoyu chuban she, 1993). 383-450; Liu Heng, *Liu Jiu Xuan Suan Shu Wu Zhong 六九軒算書五種*, Xuxiu Siku Quanshu 續修四庫全書 1046 (1851). Chi suan ri gui xin yi 尺算日晷新義, j. shang, 1a-8a, 580-583

[74] Zuonan 張作楠 Zhang, *Chuai Yue Xiao Lu 揣籥小錄*, CWSFSX (1820). 40b



Figure 3-5: Zhang Zuonan's Vertical and Horizontal Sundials. The vertical and horizontal sundials are in the courtyard of the temple. The first image shows the face of the vertical sundial. The second image shows the horizontal sundial. In the second image, one can see the vertical sundial in the background near the right center of the image. Source: Public Domain

If one used a sector, they could practice precision. One could divide the lines into much smaller units of time by repeating the procedures and fractions. Zhang wrote, "in using the method based on the proportional divider for smaller lengths, one can divide the subunits into one thousand smaller divisions. This is even more precise (mi)."[75] The "method of small lengths" referred to the construction of transversals. In his section on the *fenli chi* 分釐尺 "ruler for dividing into li," Zhang described how to use proportions to construct measurements smaller than inches. The method was derived from the *Jihe yuanben* (the translation of Euclid), and it was based on using the instrument to create slanted lines as equal cross-sections (see Figure 3-6).[76] Another method (see Figure 3-7), which he called the more efficient method, was to divide one inch into ten vertical lines equally spaced apart, followed by ten horizontal intersecting lines equally spaced apart. This could then be divided again into vertical lines to form fractional units.[77] These methods had their origins in sixteenth and seventeenth century innovations by Tycho Brahe (1546-1601) and

[75] 用分釐尺法分一千釐更密. Zhang, *Chuai Yue Xu Lu*. j. zhong, 25a
[76] Zhang, *Chuai Yue Xiao Lu*. 42b-44a
[77] Zhang, *Chuai Yue Xiao Lu*. 43b-44a

Hevelius (1611-1687) in measurement before the rise of micrometers.[78] They were described in early Jesuit translations and included in the imperial tools.[79]

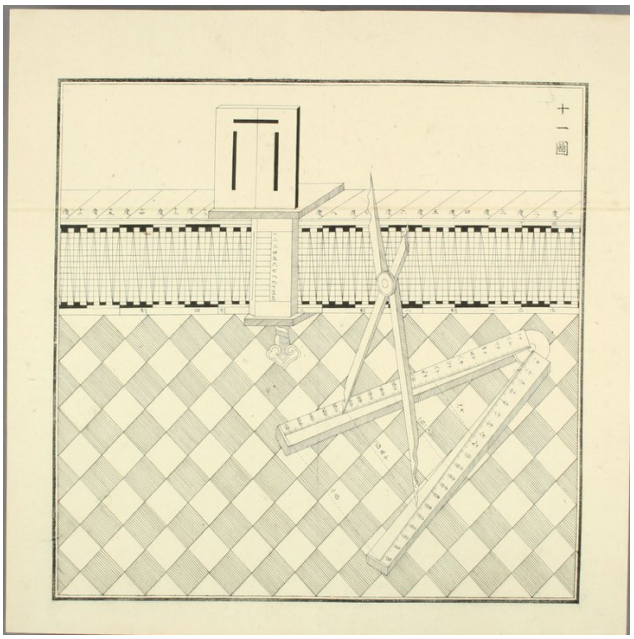

Figure 3-6: Image of Transversals. Ferdinand Verbiest used the method of transversals to add smaller measurement for the instruments of the Astronomical Bureau. Source: Ferdinand Verbiest, *Xin Zhi Ling Tai Yi Xiang Zhi* 新製靈台儀象志 (1674), 二 05 02683, Waseda University Library. Zhu yi xiang, j. 1, fig. 11

[78] Chapman, *Dividing the Circle*. 16-33

[79] Giacomo Rho, "Ce Liang Quan Yi 測量全義," Shanghai, n.d., Shanghai tushuguan. j. 10. For an analysis of the instruments and the application of these techniques to the design of the tools, see Chapman, "Tycho Brahe in China."; Baichun Zhang, "The Introduction of European Astronomical Instruments and the Related Technology into China During the Seventeenth Century," *East Asian Science, Technology, and Medicine* 20 (2003): 99–131.

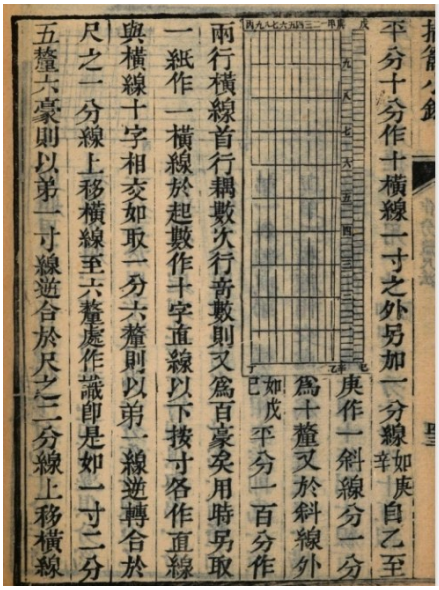
平分十分作十橫線一寸之外另加一分線如庚自乙至辛庚作一斜線分一分爲十釐又於斜線外如戊平分一百分作兩行橫線首行耦數次行奇數則又爲百豪矣用時另取一紙作一橫線於起數作十字直線以下按寸各作直線與橫線十字相交如取一分六釐則以第一線逆轉合於尺之一分線上移橫線至六釐處作識即是如一寸二分五釐六豪則以第一寸線逆合於尺之二分線上移橫線

Figure 3-7: Image of the Efficient Method for Transversals. Source: Zhang, *Chuai Yue Xiao Lu*. 43b

Zhang did not invent these procedures. They were included in the imperial curriculum. Yet Zhang wrote about them, because they connected precision to other tools. As Zhang explained, these small measurements were more effective once one had techniques for handling large amounts of numbers. Zhang chose to include these forms of precision measurement, not simply because they were powerful, but because they could now fulfill their purpose. "These tools and explanations fulfilled what scholars from the West had not yet accomplished," he wrote.[80]

Magnets

Zhang Zuonan applied these practices of precision towards better measurement of magnetic variation. Zhang knew that some sundials had to be positioned in line with true north to provide accurate hour readings. Yet compasses showed magnetic north. With a similar passion for integrating time and space, Zhang argued that setting up sundials with compasses was not good enough for measuring the kind of local precision that he imagined. As he explained it in one passage about the issue, "In observing the heavens and granting the seasons, instruments are of the utmost importance. Hence in measuring shadows and knowing the hour, the people of the past

[80] 已卯夏江雲樵為齊梅麓製比例規及對數諸尺悟得此法實足補西儒所未修因附錄於此丹邨識. Zhang, *Chuai Yue Xiao Lu*. j. 1, 44a

used sundials as one of those methods. But what the magnetic needle points to is not the line of true north."[81]

In measuring magnetism, Zhang viewed this precision in a longer practice of measuring these variations to improve tools. The study of magnetic variation had its own native tradition in China. Geomancers used three different sets of lines to account for some of the difference in magnetic variation.[82] The Song-dynasty figure Shen Kuo 沈括 (1031-1095) also documented his own trials and showed that magnetism varied differentially by location.[83] According to Zhang, contemporaries rarely took magnetic variation into account when constructing and evaluating instruments.[84] This created the potential for errors.

> Today, in studying the reality of this phenomenon each place is different. In the capital, the eastward variation is by 5 du degrees and 40 fen. If we rely on this when we make a sundial, then the noon of the winter solstice will be behind by about one ke and forty-four fen with some remainder.
>
> 今以法考之實，各處不同，在京師，則偏東五度四十分，若憑以造晷，則冬至正午先天一刻四十四分有奇.[85]

Since Zhang was interested in defining precision more carefully, any potential problem such as not aligning the sundial to the proper orientation might create errors. He viewed error as a part of the need for fixing precision. Zhang noted that some individuals believed that adding a compass to the dial ensured that one identified north and then the sundial would be in harmony and precise, namely *he* 合. But because of magnetic declination, which also impacted each individual place, compasses did not solve these errors directly.[86]

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[81] 觀象授時首重儀器而度景知時以前民用日晷其一也顧指南鍼所指非子午真線. Zhang, *Chuai Yue Xiao Lu*, Zhang Zuonan preface, 1a

[82] Joseph Needham et al., *Science and Civilisation in China*, Volume 4: Physics and Physical Technology, Part I: Physics (Cambridge University Press, 1962). 251-255, 293-314

[83] Nathan Sivin, "Shen Kua," in *Science in Ancient China: Researches and Reflections*, by Nathan Sivin (Variorum, 1995). 21-22. For the historical context of these investigations, see Daiwie Fu, "When Shen Gua Encountered the 'Natural World': A Preliminary Discussion On the Mengxi Bitan and the Concept of Nature," in *Concepts of Nature: A Chinese-European Cross-Cultural Perspective*, ed. Hans Ulrich Vogel and Günter Dux (Brill, 2010). 285-309; Ya Zuo, *Shen Gua's Empiricism* (Harvard University Asia Center, 2018).

[84] Zhang, *Chuai Yue Xiao Lu*, Zhang Zuonan preface, 1a

[85] Zhang, *Chuai Yue Xiao Lu*, Zhang Zuonan preface, 1a

[86] Zhang, *Chuai Yue Xiao Lu*, Zhang Zuonan preface, 1a-1b

How did Zhang then deal with this problem? Zhang not only incorporated magnetic declination into his instrument designs, so that they showed true north, but he also made this information publicly available so that geomancers and other time specialists could use the information to adjust their calculations. This information on adjustment was a part of the public inscription that Zhang had engraved on the monumental sundials that he commissioned for the city of Changzhou.

The sundial, which in contemporary terms is called an east-west, vertical sundial, was set up to allow for both literate and non-literate individuals to employ the sundial for spatial orientation and local time-finding. This was because Zhang intended for popular users to see visible indicators to understand the relationships between time and space, and because he intended for literate members to read and understand the specific measures employed in the data. When vertical sundials combined projections on both the walls facing direct east and direct west, they provided unique sets of information. Vertical sundials, unlike horizontal sundials, only depict the hours before or after noon (see Figure 3-8). Since the earth's rotation makes the sun appear to move from the east to the west, if the face of a vertical dial is situated directly on the east-west line, the east face will only show the hours until noon and the west face will only show the hours following exact local noon. Consequently, vertical sundials had a particular advantage for both time-finding and direction. They could show exact local noon and orientation.[87]

[87] Albert E. Waugh, *Sundials: Their Theory and Construction* (Dover Publications, Inc., 1973). 64-69; Denis Savoie, *Sundials: Design, Construction, and Use* (Springer, 2009). 98-102

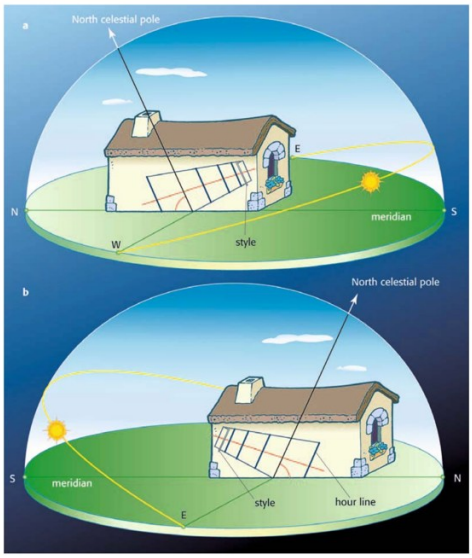

Figure 3-8: Illustration of East-West Sundials. This illustration shows the relationship between the orientation and the hour lines of the vertical sundial. Source: Denis Savoie, Sundials: Design, Construction, and Use (Springer, 2009). 100

Furthermore, Zhang's sundials incorporated two additional features that made this information even more visible to an unfamiliar viewer. First, one of the consequences of designing a vertical sundial with two faces like this was that the moment of exact noon was visibly different from any other part of the day. Although the sundial used the sun's shadow to show hours before or after noon, when the sun appeared exactly on the north-south meridian, i.e. due south, this sundial would produce no shadow at all. In Zhang's design, the sun would be directly over the top part of the stone slab. While one might imagine that a noon marker might have been helpful to show a shadow at noon, this dial used a kind of apophatic approach for witnessing when the shadow disappeared. This feature made it simple enough for anyone to be able to identify the moment of local noon and use it as a time signal.

The vertical sundial allowed one to glean information without having to read any components of the dial. Zhang designed his vertical sundial with a pin gnomon instead of a bar. While many European vertical sundials tended to use a bar that runs the length of the hour lines and points towards the north celestial pole which would have cast a shadow that appeared like a thick line, Zhang wished to enable the public to use the sundial as a tool for spatial orientation in addition to time-finding. So, if one were to stand behind the sundial between the two faces with the hours (with the sun at one's back), one would be oriented towards direct north. The two pin

gnomons would then look like two arrows pointing out the directions for true east and west. At noon, when no shadow would be visible, the individual could then use the instrument to align space into the four directions. Just like the time, one could find orientations simply by sight. This information was especially useful for local geomancy. Since the magnetic compass of geomancers was inaccurate at finding true north, any geomancer could use the public vertical sundial and not only find noon but also view all the directions to correct one's compass.

While Zhang intended for the sundial to be a public object usable for even non-literate individuals, Zhang also added written information concerning these practices. For instance, Zhang added lines and labels that divided hours into their quarter hour. And he added labels that showed how the length of the sun's shadow changed throughout the year and related to the different periods of the annual cycle. In several inscriptions on the sundial, Zhang added additional information on the specific measurements. "Today, I measured the magnetic variation in Changzhou Prefecture. It is slightly east by 3 degrees and a small amount. For those who need to determine space and fix the directions, if they use a compass, the exact north-south line will be west about three degrees when they set it up."[88] In other words, one could also read off the information and use the measurements as a standard to correct local instruments for those who were literate and able to understand the inscription.

Universal, Portable Sundials

While monumental sundials were fixed in place, Zhang also viewed precision as allowing for greater mobility.[89] Precision allowed one to apply similar principles to new places. Zhang Zuonan and his friends therefore designed portable instruments that allowed for similar practices of precision. These instruments would allow one to practice this type of precision measurement from anywhere in the empire.

Qi Yanhuai was the first among this group to work on a more universal solution. In Zhang's telling, Qi sent Zhang a prototype of his design in the fall of 1819.[90] The new sundial was based

[88] 今測得常州府城指南鍼偏正午東三度弱辯方定向須於羅鍼正午偏西三度取之. *Wujin Tian Ning Si Zhi 武進天寧寺志*, Airusheng (1947). j. 5, 4b, 103; Shengchi 郭盛炽 Guo, "Changzhou Tianning Si Qing Dai Ri Gui Ji Qi Fu Yuan She Ji 常州天寧禅寺清代日晷及其复原設計," *Shanghai Tian Wen Tai Nian Kan* 14 (1993): 303–9.
[89] Kathleen Higgins, "The Classification of Sundials," *Annals of Science* 9, no. 4 (1953): 345.; Sara J. Schechner, *Time of Our Lives: Sundials of the Adler Planetarium* (Adler Planetarium, 2019). 185-186
[90] Zhang, *Chuai Yue Xiao Lu*, Zhang Zuonan preface, 1b

on the imperial model of the vertical east-west dial, but it differed in some important ways from the more common design (see Figure 3-9). Relying on the principles of proportion and measurement from the *Shuli jingyun*, Qi called his instrument an "inclining dial" or *xiegui* 斜晷. Like a vertical east-west dial it contained two faces which displayed the hours before and after noon on the respective face. But instead of being designed in a rectangular shape and fixed in place, the instrument was situated inside a curved slot so that the faces could rotate along the curve.

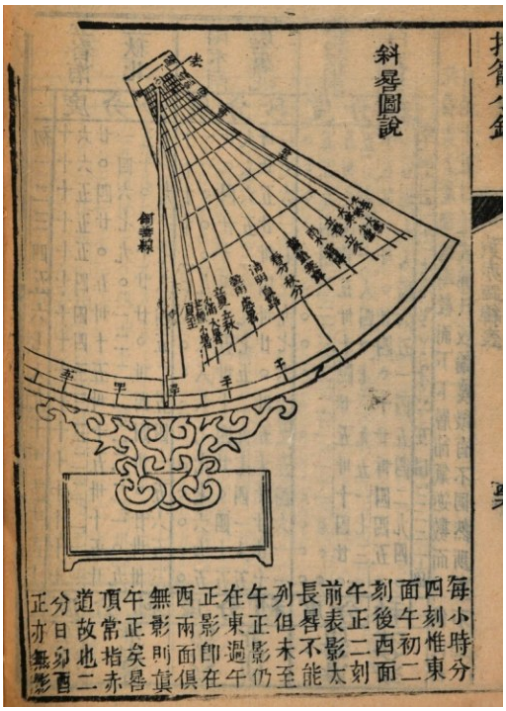

Figure 3-9: Illustration of the Inclined Dial. This is the diagram for Qi's model. At the top of the image is a small line indicating the pin gnomon. The large rod that comes down from the center point is the plumb line, *tongchui xian* 銅垂線. The fanning lines represent the seasonal divisions, and the lines parallel to the origin of the gnomon are the hour lines. At the bottom of the dial is a curve with angles of latitude. Source: Zhang, Chuaiyue xiaolu, 49b-50a

The sundial might be more accurately described as an inclining direct east-west sundial adjustable for latitude (for comparison, see the inclining cube sundial Figure 3-10).[91] To use Qi's

[91] Vertical dials are not usually made into portable instruments. We tend to think of vertical dials as fixed in place or particular dials. There are many horizontal dials that include latitude adjustments, such as the popular Augsburg dial type. But to avoid confusion with the two types of dials, I prefer simply describing Qi's dial as a type of "adjustable" vertical dial. Some verticals are described as "declining" dials. Declining vertical dials, however, refer to the angle of orientation or the angle of declination, instead of being direct east, west, or south. In the eighteenth century, David Beringer (1756-1821) and George Paul Seyfried (1725-c.1776) did produce cube dials that could be sold for large geographic areas. These dials included latitude information for adjustment. Qi's dial shared some similarities

dial, one placed it on a flat surface and made it level. Then fixing a plumb line at the hole where the pin gnomon attached to either of the dial faces, one let the plumb line form a straight line towards the ground. With the plumb line hanging, one could then rotate the dial. On the bottom of the dial, there was a ring which marked each degree latitude. To adjust the instrument, one needed to rotate the dial within its curved slot until the latitude of one's location aligned with the hanging line. Once the dial was fixed to the person's latitude, then one could remove the plumb line and read the dial like any other vertical, east-west dial.[92] When Zhang first saw the device, he was ecstatic to have an instrument that could be used at multiple latitudes. "Noting that the polar height variations could be measured anywhere, I exclaimed that this matched my own thinking perfectly."[93]



Figure 3-10: Illustration of Beringer Polyhedral Sundial. Compare Qi Yanhuai's design with polyhedral dials. Polyhedral dials combined horizontal and vertical sundials with multiple directions to create mathematical displays. Some polyhedral dials were also adjustable, like these Beringer dials. This polyhedral dial allowed one to incline the cube for the proper latitude as read by the position of the hanging plumb line against the latitude scale (not visible in this image). Source: David Beringer, Polyhedral Dial, 1777-1821, Wood, 186 x 78 x 98 mm, National Maritime Museum.

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with this style, but Qi's dials were two-sided instead of cubes. For additional information on classification and these types of dials, see Bruce Chandler and Clare Vincent, "Three Nürnberg Compassmacher: Hans Troschel the Elder, Hans Troschel the Younger, and David Beringer," *The Metropolitan Museum Journal* 2 (1969): 211–16.; Higgins, "The Classification of Sundials."; Schechner, *Time of Our Lives*. 228-265, 330-337

[92] 斜晷圖說每小時分四刻惟東面午初二刻後西面午正二刻前表影太長晷不能列但未至午正影仍在東過午正影即在西兩面俱無影則真午正矣晷頂常指赤道故也二分日卯酉正亦無影此齊梅麓所新製也其法遵御製數理精蘊作橫表面東西日晷法依表式立表於二分綫及卯酉正綫十字交點處（卯酉正綫至己申初綫兩綫相距為表長表式準此）橫平中矩勿令長短欹側乃掛銅垂綫於表位上指天頂下指地心將晷進退推移令垂綫刻末切各方北極出地度分平置日中取準即去垂綫恐礙表影. Zhang, *Chuai Yue Xiao Lu*, 49b-50a

[93] 按極度低昂可隨處測驗歎為先得我心. Zhang, *Chuai Yue Xiao Lu*, Zhang Zuonan preface, 1b

After receiving Qi's creation, Zhang Zuonan and Jiang Lintai thought to improve it. They praised the basic design principle which incorporated latitude adjustments for inclining the dial, but they thought they might be able to offer additional functions and aesthetic qualities to the instrument. For example, they changed its shape (see Figure 3-11). Qi had designed his original instrument with an unusual shape which focused on the fan-like distribution of the hours and the seasons. According to the template image he produced, Qi had initially set up his instrument according to 30 degrees north.[94] He then provided the rest of the degrees in the bottom curve. This produced an effect such that the latitude scale stretched outward beyond the hour lines but left the space empty. Zhang Zuonan and Jiang Lintai filled in the interior and made it into a circle. Looking more like a classical bronze mirror, they renamed the sundial as a "circular dial". In technical terms, however, the dial still functioned as a direct east-west dial for latitudes. Hence, each of the two sides remained facing east and west, and one still needed to use a plumb line as the line with which to calibrate the latitude. But whereas the latitude adjustment in Qi's instrument had stuck outward, in their design, it was now included in the entire ring and started at 15 degrees and went up to 55 degrees.[95]

[94] Zhang, *Chuai Yue Xiao Lu*, 49b
[95] Zhang, *Chuai Yue Xiao Lu*, 50b

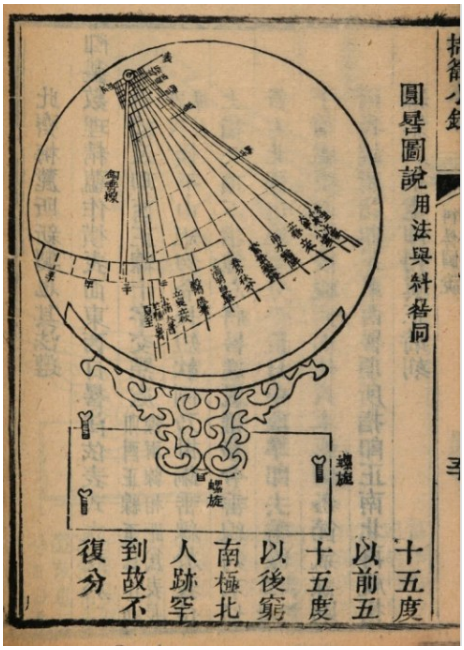

Figure 3-11: Illustration of the Circular Dial. Zhang Zuonan updated Qi's model in several ways. First, he changed the design to be circular like a bronze mirror. Second, he incorporated screws that allowed one to adjust it. But many of the same elements were carried over. The dial contained the pin gnomon at the top and a hanging plumb line. The hour lines and seasonal lines were the same. The sundial also contained a curve for creating latitude adjustments, but it was placed higher. Source: Zhang, Chuai Yue Xiao Lu, 50b

In addition to producing a new shape, the designers also fixed the bottom half of the instrument. According to Zhang Zuonan, when they had first set up Qi's artifact, they experienced some difficulty in leveling the instrument. Because Qi's design had been fixed at the base, it was hard to adjust it to different platforms. So, Jiang Lintai changed the base with a set of rotating screws. The screws helped one level the instrument for uneven surfaces and offered control over each of the different regions for more accuracy. Now, with the screws, one could stabilize the instrument better and improve its performance.[96]

All of these fine adjustments helped transform this instrument into a practical tool that could be used for any latitude. Although other sundials were fixed in place, these latitude-adjustments meant that the instrument could be portable and applied anywhere in the empire. Zhang wrote:

> The one who makes sundials must set them up using the *licha* [league difference], given that one sundial from one place cannot be generalized for all other locations

[96] Zhang, *Chuai Yue Xiao Lu*, 51a-52b

> on the earth. Horizontal sundials [where the shadow template is placed on a plane] use the tangent and the secant lines from the degree toward the north celestial pole as the hypotenuse of the sun's shadow. This is difficult to make into a universal instrument. Therefore, only east-west facing vertical sundials that combine the equatorial line with the polar line can be calculated for adjustment. Meilu [i.e. Qi Yanhuai] understood this principle and created an inclined-face sundial which moved at the base according to one's polar degree. One could use it for measurement and verification wherever. The method was truly excellent!
>
> 為之者，按作諸日晷，必以里差為準，故一方一晷，不能率土，皆通緣平面晷，以極高度切割綫為影弦，難以通行，故也惟面東西立晷，以赤道綫加極高度綫，始可推移，梅麓悟得此理，製斜面活晷，按極度低昂，可隨處測驗，法誠善矣.[97]

Zhang compared the construction process between horizontal and vertical dials as a reason why their new dials were suited for portability. In constructing particular horizontal dials, one did, indeed, incorporate latitude into the hour lines. While there were in fact other ways to construct universal dials, including equinoctial dials, polar dials, or latitude-adjusting horizontal dials, Zhang was especially focused on the functions of the length of the shadow and finding a meridian. From the construction standpoint, the hour lines were simpler for the vertical sundial. Since he wished to have a grid for following the lengths of the solar shadow, which we will return to below, Zhang especially praised the vertical sundials over the horizontal sundials.

Zhang claimed that these objects were not just solutions for finding time and making precise local measurements, but these were tools that made verification public and participatory. The two sundials made it possible that one might be able to practice observation and verification in multiple places. They allowed for a far wider community to practice these procedures and techniques. Moreover, these two sundials, the *xiegui* and the *yuangui*, were added to his general treatise on constructing vertical and horizontal sundials. The book on sundials had already translated the geometric procedures for constructing hour and seasonal lines. It made this information accessible. By appending illustrations of these special designs in his book, Zhang

[97] Zhang, *Chuai Yue Xiao Lu*, 51a

intended for users to work with the models and construct their own. In all these ways, he was working to make technical knowledge more public and useful.[98]

3.3 From Astronomical to Ritual Precision

Why did Zhang use this language of precision? How was one supposed to apply this knowledge? Zhang Zuonan encouraged more engagement with precision because mathematical and astronomical concepts could be used for governance. These tools and calculators allowed for local politics to connect with the state. By focusing on time and simultaneity, Zhang was introducing an important factor in which the state needed to focus on shared rituals of social order. The tools to practice time overlapped with the larger tools of organizing local government.

Defining Ritual Precision

Statecraft or political reform required what I am calling "ritual precision". Ritual precision refers to a specific attitude for how to practice rituals and apply them. Rituals or *li* 禮 in Confucian theory were the behaviors and routines that structured society. Rituals helped define social relationships and the expected patterns of behavior regulating those relationships. There were rituals of private and domestic life, and there were rituals in state life. Although the practice of rituals had certain elements of convention, and rituals were viewed as a form of moral self-cultivation, rituals were secular. Those who studied ritual were well-aware that ritual practice had changed over time. Confucian views of ritual accepted that rituals were man-made. Humans created rituals. If they made them, then they could change them too. The key to ritual studies was about action and adjustment. Rituals had to fit the right context.

Therefore, as I am using it, ritual precision reflected two distinct themes: standardization and quantification. First, ritual precision reflected both the state's vision to create standardized models of ritual practice and routine across the empire and private scholar's goal to clarify and update historical rituals in the present. These goals were not necessarily the same. But they came together through the shared vision of classical scholarship. Education centered heavily on the instruction in propriety and the rules regulating behavior. The government encouraged this training

[98] 作日晷諸法於前並附此圖於後俾人人可仿製焉. Zhang, *Chuai Yue Xiao Lu*, 52b

through the production of new textbooks and the sponsorship of ritual scholarship. These books were meant to clarify classical ritual and define its context with more precision.[99] Individual scholars also participated in these studies of ritual by exploring classical texts as a form of moral reform. As Kai-Wing Chow has argued, "The ritualist approach to moral cultivation and to social solidarity through strengthening kinship ties helped re-establish the gentry as the intellectual, moral, and social leaders of local society."[100] This is to say, that the values of classicism helped form a distinct approach toward rituals that aimed to distinguish, analyze, and apply these rituals for specific functions, a type of precision.

But this view toward ritual was new insofar as it quantified rituals. Ritual was one of the most important aspects of Confucian theory. What therefore constituted a unique approach toward these new applications of ritual was its quantified nature. Drawing on the application of technical skills for the study of classics, quantification allowed one to create the proper forms of standardization. In other words, by quantifying rituals, and defining ritualized practices in measured formats, scholars could allow rituals to become more mobile and applicable. Since literati transformed standardization as a tool for promoting local gentry control and collaboration with the state, this quantified vision of ritual measurement and determination placed new forms of authority and expertise in the management of tools for quantification. Zhang Zuonan incorporated his approaches toward quantifying and measuring time under more precise values as a way to recover the classical theories of rituals. These state and private rituals offered a template that he thought would promote a moral theory of local governance.

Classical Ideals

That Zhang's goal was both about refining the types of rituals in public life and about increasing the actual practice of precision itself through rituals becomes clearer when we understand that

[99] Patricia Ebrey and Limin Bai have both explored this context. Ebrey has used commentaries and publications to show how ritual standardization and the state were collaborative. Limin Bai has looked at the moral literature in children's education to see how ritual propriety was distributed to different social communities. Ebrey, *Confucianism and Family Rituals in Imperial China*; Bai, *Shaping the Ideal Child*. Although regional diversity mattered, Richard Smith has argued that ritual is the key to understanding the state's theory of unity. "It was through orthodoxy ritual (*li*)—as well as closely related systems of law and education—that the Ch'ing state sought to encourage cultural uniformity and minimize diversity and social deviance." Richard J. Smith, "Ritual in Ch'ing China," in *Orthodoxy in Late Imperial China*, ed. Kwang-Ching Liu (University of California Press, 1990). 282-283

[100] Kai-wing Chow, *The Rise of Confucian Ritualism in Late Imperial China: Ethics, Classics, and Lineage Discourse* (Stanford University Press, 1994). 1

Zhang's designs for sundials were clever adaptations and reconstructions of ritual implements or the sets of tools involved in conducting state rituals. He used geometrical reasoning to structure and refine the practice of finding seasons. The terms and designs that Zhang promoted in his treatises on sundials therefore have to be understood from the broader context in which statecraft reformers studied the last chapter in the *Zhouli* 周禮 *Rites of Zhou*. This text provided idealized versions of the state from which reformers tried to compare their current affairs.

First, Zhang used the language of *gui* 晷 when conversing about his time instruments. Functionally speaking, the term *gui* could refer to what is today called a "sundial". *Gui* meant something like a "shadow template". It contained the radical for the sun, and it referred to the diagram that represented the shadows cast from a gnomon. But if we are using "sundial" in the sense of an instrument for finding an hour or time during the day, the notion of a shadow template and dial plate is not quite the same. Dial plates could depict equal and unequal hours, and some types of dial plates were even used to show annual differences. The concept of the *gui* is similar in that it too referred to the path of the sun throughout the year. But because the term *gui* was connected to historical practices of measurement that were ritually determined, the idea of the *gui* was also connected to the measuring of the length of a shadow rather than the focus on indicating time or the division of the day. Such a slight conceptual difference meant that while the dial plates associated with sundials might look like the dial plates called *gui*, dial plates focused on communicating hours whereas the *gui* plates focused on season. Western missionaries contributed to this confusion when they adopted the term *gui* to translate sundials; and, in official astronomical literature, the term *gui* came to complement the idea of latitude and longitude. It was used to mean a "sundial" or another type of dialing instrument. But the translation was not a one-to-one equivalence and remained unevenly employed even into the nineteenth century.[101]

One way to understand this better is through the terminology used to refer to instruments of time-finding in classical sources. Historically, there were several terms that overlapped with time-finding ritual tools, and these terms had different shades of meaning depending on the use.[102]

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[101] Zhang, "From Fenye to Latitude and Longitude." 90-92

[102] Joseph Needham and Ling Wang, *Science and Civilisation: Mathematics and the Sciences of the Heavens and the Earth*, vol. 3 (Cambridge University Press, 1959), 302-313.; Christopher Cullen, *Astronomy and Mathematics in Ancient China: The Zhou Bi Suan Jing* (Cambridge University Press, 1996) 101-128.; John S. Major et al., trans., *The Huainanzi: A Guide to the Theory and Practice Government in Early Han China* (Columbia University Press, 2010): Section 3.16.; Li Jiancheng, "Gui Yi: Wo Guo Xian Cun Zui Gu Lao de Tian Wen Yi Qi 晷儀：我國現存最

For instance, classical sources had terms for both the upright pole used to cast the shadow and the shadow that resulted from the pole. One of the most common terms for the pole was the *biao* 表 "gnomon". It was also called *bei/bi* 碑 "stele" and *bi* 髀 "gnomon". There were different terms for the projection of shadows. Besides *gui* 晷, classical sources named the *jing* 景 "the sun's projection/shadow". This projection occurred on a jade tablet that was also confusingly called a *gui* 圭.

There were other objects called *gui* in these contexts of ritual measurement and time-finding. The term *gui* 規, meaning compass, could also be used here. On the one hand, this sense of compass meant the complement to the carpenter's square, the *ju* 矩 tool. But the compass itself might also refer to the action of tracing the circle, i.e. the result of using a compass. Moreover, since the circle and square were often treated as analogies of heaven and earth, the term could be used in the context of tracing the paths of the celestial bodies, as in drawing circles with a compass that depicted the celestial movements. Although a somewhat mystical application of the terminology more associated with Daoist traditions, these associations belonged to the semantic field and cosmology implied by time-finding.[103]

There are the challenges involved in interpreting classical sources related to these historical instruments. One must determine whether these are examples of mixed terminology, specific implements, actions resulting from the instrument, or broader metonymies.

To make this even more challenging, the jade tablet referred to by the term *gui* 圭 was only one jade instrument used in classical rituals and described in texts on ritual implements. The *Kaogongji* 考工記 *Artificer's Record* describes several types of jade tablets under the category of *gui*. There were *zhengui* 鎮圭, *henggui* 桓圭, *xingui* 信圭, and *shegui* 躬圭. The jade tool used in

古老的天文儀器," in *Zhongguo Gu Dai Tian Wen Wen Wu Lun Ji 中國古代天文文物論集*, by Zhongguo she hui ke xue yuan. Kao gu yan jiu suo 中国社会科学院考古研究所编辑 (Wen wu chu ban she, 1989).; Liu Fu, "Xi Han Shi Dai de Ri Gui 西漢時代的日晷," *Guo Li Bei Ping Da Xue Ji Kan* 3, no. 4 (1932): 573–610. William C. White and P. M. Millman, "An Ancient Chinese Sundial," *Journal of the Royal Astronomical Society of Canada* 32, no. 9 (1938): 417–30.; Guo Shengchi, "Guan Yu Xi Han Ri Gui 關於西漢日晷," in *Zhongguo Tian Wen Xue Shi Wen Ji 中國天文學史文集*, vol. 3, ed. Zhongguo tianwenxue shi wenji bianjizu (Beijing, 1984); Yunli Shi et al., "Xi Han Xia Hou Zao Shi Chu Tu Tian Wen Yi Qi Xin Tan 西漢夏侯灶墓出土天文儀器新探," *Zi Ran Ke Xue Shi Yan Jiu* 31 (2012): 1–13.

[103] For comparison, see Burton Watson, *The Complete Works of Zhuangzi* (Columbia University Press, 2013).; Matthias Schemmel and William G. Bolz, *Theoretical Knowledge in the Mohist Canon* (Springer Cham, 2022); Chris Fraser, *The Philosophy of the Mòzǐ: The First Consequentialists* (Columbia University Press, 2016); Angus C. Graham, *Later Mohist Logic, Ethics and Science* (1978; Chinese University Press, 2003).

measuring solar shadows was called the *tugui* 土圭.[104] There were other jade tablets employed in celestial rituals. The *guibi* 圭璧 is described as a jade tablet used in the ceremonies for the sun, moon, and the stars.[105]

Although to what extent these texts referred to actual practice is uncertain, the texts and their commentaries provide some insights into the idealized vision of practice with these instruments.[106] According to the *Rites of Zhou*, the *tugui* or the measuring *gui* tablet was supposed to be used in the determination of the seasons. The ritual overseer could use it for measuring depth and for finding the changing lengths of solar shadows in the year. The original text described the sun in the four locations. Later commentaries clarified that this was the practice of measuring at noon to identify direction and determine seasons providing the lengths of the sun's shadow.[107] The *Rites of Zhou* also described other situations for using the tool. It was the instrument employed in wider surveying and measuring the landscape. In applying the instrument, the state could define its borders and fix the physical boundaries.[108]

The *Rites of Zhou* was not the only classical text that included material on using shadow templates. The *Zhoubi suanjing* included similar information. The *Zhoubi suanjing* was an early Han dynasty text that included mathematical procedures for conducting astronomy.[109] In terms of theory, the *Zhoubi suanjing* preferred the *gaitian* theory. The book used algorithmic procedures as guides for solving prediction problems.[110] Although the *huntian* theory supplanted the *gaitian* cosmology, the *Zhoubi* provided important material on mathematics and practice. As a result, the book included different sets of procedures related to the laying out of shadow templates. It also provided procedures for separating out the length of the solar shadow according to different times

[104] *Tu* is understood as an alternate reading for the character *du* 度 meaning measurement. *Zhou Li 周禮*, Si Bu Cong Kan Chu Bian 9 (Shang wu yin shu guan, 1929) j. 3, 13b-14b.; Édouard Biot, trans., *Le Tcheou-Li; Ou, Rites Des Tcheou* (Imprimerie nationale, 1851) Vol 1, 200.
[105] *Zhou Li*. j. 12, 2b-3a; Biot, *Le Tcheou-Li*. Vol 2, 523-524
[106] For more discussion of the text and scholarship, see William G. Bolz, "Chou Li 周禮," in *Early Chinese Texts: A Bibliographical Guide*, ed. Michael Loewe (Society for the Study of Early China, 2007). 24-32
[107] *Zhou Li*. j. 3, 14a
[108] *Zhou Li*. j. 3, 14b-15b
[109] Christopher Cullen, "Chou Bi Suan Ching 周髀算經," in *Early Chinese Texts: A Bibliographical Guide*, ed. Michael Loewe (Society for the Study of Early China, 2007); Cullen, *Astronomy and Mathematics in Ancient China*.
[110] For additional detail and comparison on these methods, see Cullen, *Astronomy and Mathematics in Ancient China*; Christopher Cullen, *The Foundations of Celestial Reckoning: Three Ancient Chinese Astronomical Systems* (Routledge, 2017); Cullen, *Heavenly Numbers*.

of the year.[111] In sum, the measurement practices were meant to support the definition of identifying specific moments in time and allow one to continue in the annual ritual cycle.

State Rituals

Texts like the *Zhoubi suanjing* and the *Zhouli* describe observational practices, but for medieval authors, they only related to ceremonial moments or specific practices when the state needed to fix calendars.[112] However, as ideals, scholars tried to study these texts to support state rituals and develop more precise measurements for constants used in astronomical systems.[113] The language for these rituals became increasingly linked to quantified procedures through translations of Western geometry.

By the late Ming, the introduction of Western geometry and the practice of making and using sundials started to impact this scholarly tradition. The Jesuits introduced a new geometric dimension to classical research on the gnomon as they connected trigonometry to the practice of shadow measurement. The Jesuits translated works on dialing, especially Christopher Clavius' textbooks on the astrolabe and geometry.[114] These works used trigonometric proportions as a model for drawing templates and lines. Such material included Li Zhizao's *Hungai tongxian tushuo* 渾蓋通憲圖說 (1607) and Sabatino de Ursis' (1575-1620) *Biaodu shuo* 表度說 (1614). In

[111] Cullen, *Astronomy and Mathematics in Ancient China*. 178, 192, 193ff, 196-197
[112] Morgan, *Astral Science in Early Imperial China*.; Arthur Beer et al., "An 8th-Century Meridian Line: I-Hsing's Chain of Gnomons and the Pre-History of the Metric System," *Vistas in Astronomy* 4 (1961): 3–28.; Sivin, *Granting the Seasons*.
[113] Deane, "The Chinese Imperial Astronomical Bureau." 248-250, 418
[114] Frederick A. Homann, "Christopher Clavius and the Renaissance of Euclidean Geometry," *Archivum Historicum Societatis Iesu* 52 (1983): 78–96.; James M. Lattis, "Christopher Clavius and the 'Sphere' of Sacrobosco: The Roots of Jesuit Astronomy on the Eve of the Copernican Revolution" (Phd Dissertation, University of Wisconsin, Madison, 1989).; Jean-Claude Martzloff, "Clavius Traduit En Chinois," in *Les Jésuites à La Renaissance: Système Éducatif et Production Du Savoir*, ed. Luce Giard (Presses universitaires de France, 1995).; Catherine Jami, "From Clavius to Pardies: The Geometry Transmitted to China by Jesuits (1607-1723)," in *Western Humanistic Culture Presented to China by Jesuit Missionaries (XVII-XVIII Centuries): Proceedings of the Conference Held in Rome, October 25-27, 1993*, ed. Federico Masini (Institutum Historicum S.I., 1996), 175-199.; Kam-Wing Fung 馮錦榮, "Christopher Clavius and Li Zhizao," in *The Spread of the Scientific Revolution in the European Periphery, Latin America and East Asia*, ed. Celina A. Lértora Mendoza et al. (Brepols, 2000).; Fung Kam-Wing, "Ming Mo Xi Fang Ri Gui de Zhi Zuo Ji Qi Xiang Guan Dian Ji Zai Zhongguo de Liu Bo: Yi Ding Xian Sheng (Christoper Clavius, 1538-1612) 'Gui Biao Tu Shuo' ('Gnomonices', 1581) Wei Zhong Xin 明末西方日晷的製作及其相關典籍在中國的流播: 以丁先生(Christoper Clavius, 1538-1612)"日晷圖說" 'Gnomonices', 1581) 為中心," in *Zhong Wai Guan Xi Shi: Xin Shi Liao Yu Xin Wen Ti 中外關係史: 新史料與新問題*, ed. Rong Xinjiang and Li Xiaocong (Ke xue chu ban she, 2004).

addition to the materials used in calendar translation, some missionaries and other astronomers also composed treatises on dialing which circulated in manuscript form.[115]

As one of the texts included in the early collectanea on "celestial sciences", the *Biaodu shuo* is an exemplar of this new geometrical interpretation of classical ritual.[116] The work explains the basic knowledge of the celestial sphere and the relationship to spherical trigonometry. Beyond explaining the basic spherical trigonometry involved in conducting latitude measurements, the text also explored how geometry impacted the setting up of the gnomon. The text provided models of gnomons that were related to the Chinese ritual tradition.[117] But it also included examples that were set up against walls or uneven surfaces.[118] De Ursis and his translators produced detailed lists of measurements that demonstrated how to apply the concept for measuring shadows from multiple angles and how the observational evidence might be used to reform the calendar.[119] In other words, vertical and horizontal dials could be related to the Chinese tradition of setting up the gnomon based on the connection to the pillar.

Although the Zhou rituals were ideal types rather than strict models, the Qing made efforts to promote the study of classical rituals and claimed that their practices were historical continuities. During the Kangxi reign, the emperors commissioned the Ministry of Rites to create standardized versions of ritual tools and implements through historical studies.[120] The Ming and the Qing also created state projects that published standardized versions of domestic rituals.[121] In addition to the publication of the orthodox curriculum on Zhu Xi, private scholars returned to classical texts on ritual as a part of their study on lineage descent. Wan Sida 萬斯大 (1633–1683), a classical scholar

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[115] Xu Jie and Yunli Shi, "Pang Diwo, Sun Yuanhua 'Ri Gui Tu Fa' Chu Tan: Jian Lun Niu Jin Ben Tian Wen Lue Zhong de San Zhong Gui Yi 龐迪我，孫元化'日晷圖法'初探：兼論牛津本天文略中的三種晷儀," *Zi Ran Ke Xue Shi Yan Jiu* 25, no. 2 (2006): 149–58.

[116] For more on this book, see Chen Mingsheng, "Li Chih-Tsao and the 'T'ien-Hsüeh Ch'u-Han,'" in *Echanges Culturels et Religieux Entre La Chine et l'Occident*, ed. Edward J. Malatesta et al. (Ricci Institute for Chinese-Western Cultural History, 1995).; Lü Mingtao, "'Tian Xue Chu Han': Ming Qing Jian Zhong Xi Wen Hua Jiao Liu de Biao Ben '天學初涵': 明清間中西文化交流的標本," *Tai Shan Xue Yuan Xue Bao* 32, no. 4 (2010): 8–13.

[117] Li Zhizao, *Tian Xue Chu Han 天學初涵*, Bian qi zhong 編器中 (Shanghai jiao tong da xue chu ban she, 2013). 682; Sabatino de Ursis, *Biao Du Shuo 表度說* (1614), Tianyi ge, j. 1, 24a-24b.

[118] Li, *Tian Xue Chu Han*, Bian qi zhong 編器中, 660-664; de Ursis, *Biao Du Shuo 表度說,* j. 1, 11a-15a.

[119] Li, *Tian Xue Chu Han*, Bian qi zhong 編器中, 666-681, 690-694; de Ursis, *Biao Du Shuo 表度說,* j. 1, 15b-23b, 27a-33b.

[120] For this process see Keliher, *The Board of Rites and the Making of Qing China*.

[121] Chu Hsi, *Chu Hsi's Family Rituals: A Twelfth-Century Chinese Manual for the Performance of Cappings, Weddings, Funerals, and Ancestral Rites*, trans. Patricia Buckley Ebrey (Princeton University Press, 1991), xxx-xxxi.

on the Spring and Autumn Annals, published critical texts on the three classics of ritual. Qin Huitian 秦蕙田 (1702-1764), one of the leading interpreters of the classical tradition in the eighteenth century and a scholar involved in imperial education, published his monumental work on rituals to standardize the different sources on public and private rituals.[122]

Official publications made explicit connections between classical interpretation and the use of these instruments for the state. For instance, during the Qianlong reign, the Ministry of Rites published a new set of illustrated diagrams of all the items used in state rituals, including artifacts, clothing, and tools. The items were categorized by ritual function and type: *jiqi* 祭器 sacrificial tools; *yiqi* 儀器 ceremonial tools; *guanfu* 冠服 caps and robes; *yueqi* 樂器 music instruments; *lubu* 鹵簿 insignia; and *wubei* 武備 military objects. Astronomical instruments were a sub-category of the ceremonial tools. The astronomical tools included all the instruments used in measuring and surveying. The instruments included the official state gnomon and *gui* for measuring shadows on the solstices and the equinox. According to the description, the authors explained that the instrument connected the Qing to the ancient practices of the Zhou. Despite the changes in instruments used for measuring, the gnomon established important terms used in other measurements. Although the gnomon for the Qing dynasty was slightly longer than the classical model, the gnomon was set up near the Astronomical Bureau as a part of the wider set of instruments used in establishing calendars.[123]

Ritual Scholarship

Private scholars were also involved in synthesizing these practices. In addition to his studies of the five types of rituals, Qin Huitian also conducted a special study on the rites related to time. These studies were focused on the astronomical calculations and measurements that were used to create the calendar. Drawing on the commentaries of Li Guangdi 李光地 (1642–1718), Qin used quantitative measurements as a model for understanding how ancient practice functioned and as a

[122] Chow, *The Rise of Confucian Ritualism in Late Imperial China*.
[123] Yunlu and Jiang Pu, eds., *Huang Chao Li Qi Tu Shi 皇朝禮器圖式* (Wu ying dian, 1759), Harvard-Yenching Library, j. 3, 63b-64a.

means of interpreting the classical tradition.[124] Jiang Yong 江永 (1681-1762), Shen Tong 沈彤 (1688-1752), Cheng Yaotian 程瑤田 (1725-1814), and Ruan Yuan all contributed to this aspect of quantification with their application of mathematical and geometric reasoning on the Zhou texts. These scholars explored textual issues and prioritized the final chapter of the *Kaogong ji* as an example of textual authority. They investigated this content through rigorous study for the purpose of recovering ancient rituals and applying them again to society.[125]

In the context of studying the gnomon and rendering seasonal rituals more visible, Dai Zhen 戴震 (1724-1777) was one of the most important precursors to Zhang Zuonan. While Dai Zhen was famous for his focus on historical phonology, he studied with Jiang Yong and applied his technical knowledge to the classical texts.[126] He wrote extensively about the Zhou rituals and worked on both the *Zhoubi suanjing* and the *Kaogong ji*. In order to explain the ritual for finding the seasons, Dai Zhen elaborated on a set of illustrations that were ascribed to Jiang Yong. These illustrations provided a visual model to understand the solstice rituals. It adapted the material from Western learning on the trigonometry involved in the gnomon and the shadow to explain the classical text. Like the hour lines of a sundial diagram, the circle diagrams were meant to support one to find noon. Although noon measures at the equinoxes and the solstices were the primary features of this method, the discussion in this literature combined a new set of sources to clarify the terminology in the classics.[127]

[124] Qin Huitian, *Guan Xiang Shou Shi 觀象授時*, Huang Qing Jing Jie (Xue hai tang, 1861), j. 288-j.301. For more on Li Guangdi and mathematical astronomy in classical interpretation, see Han Qi, "Patronage Scientifique et Carrière Politique: Li Guangdi Entre Kangxi et Mei Wending," *Études Chinoises* 16, no. 2 (1997): 7–37.; On-Cho Ng, *Cheng-Zhu Confucianism in the Early Qing: Li Guangdi (1642-1718) and Qing Learning* (State University of New York Press, 2001).; Jami, *The Emperor's New Mathematics*., 68-70, 122-131

[125] Cheng Yaotian, *Cheng Yaotian Quan Ji 程瑤田全集*, vol. 3 (Huangshan shushe, 2008); Yaotian 程瑤田 Cheng, *Cheng Yaotian Quan Ji 程瑤田全集*, vol. 2 (Huangshan shushe, 2008); Shen Tong, *Zhou Guan Lu Tian Kao 周官祿田考*, Huang Qing Jing Jie (Xue hai tang, 1861); Jiang Yong, *Zhou Li Yi Yi Ju Yao 周禮意疑舉要*, Huang Qing Jing Jie (Xue hai tang, 1861).; Benjamin A. Elman, "The Story Of A Chapter: Changing Views Of The 'Artificer's Record' ('Kaogong Ji' 考工記) And The Zhouli," in *Statecraft and Classical Learning: The Rituals of Zhou in East Asian History*, ed. Benjamin A. Elman and Martin Kern (Brill, 2009).

[126] Hu, *China's Transition to Modernity*. 72-75

[127] Dai Zhen, *Dai Zhen Quan Shu 戴震全書*, vol. 5 (Huangshan shushe, 2010). j. xia, 421-426

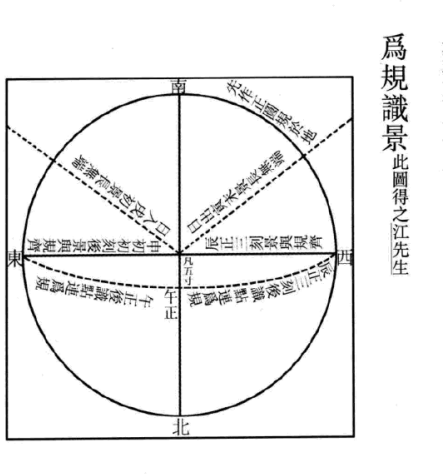

Figure 3-12: Jiang Yong's Illustration for Measuring Shadows. The image represents the passage on "making a circle to identify the shadow." The image is attributed to Jiang Yong. First, the earth is represented as the square, and then the heavens are represented as the inscribed circle. The circle is divided into the four directions with south at the top. The angled, dotted lines represent the sun's rising and setting. The curved, dotted line represent the hours before and after noon. Where the dotted line crosses the north-south line is labeled as exact noon, and the distance from the center of the circle is five cun inches. The image provides a working model to understand the identification of noon as a repeated ritual for measuring the passing of time. Source: Dai Zhen, Dai Zhen Quan Shu 戴震全書, vol. 5 (Huangshan shushe, 2010). j. xia, 424

These types of illustrations were important for reconstructing historical artifacts. Dai Zhen's models included new measurements that could be used to check the historical texts. In the case of the ritual bells, Dai Zhen calculated new sizes (see Figure 3-13). The measurements were largely reconfirmed with the discovery of Zhou-period bells in 1761.[128] Cheng Yaotian similarly worked with bronze artisans to cast new ritual instruments that were based on the specifications of the historical work.[129] The bells were not the only tool that received this treatment. There were contemporary efforts to clarify the measurements of the ancient *mingtang* 明堂 "Palace of Light" and size of classical chariots as well.[130] Zheng Zhen 鄭珍 (1806-1864) introduced these scholarly trends to new regions with his own reconstructed measurements and hand-drawings of bells and chariots.[131]

[128] Elman, "Statecraft and Classical Learning." 353
[129] Elman, "Statecraft and Classical Learning." 353-354
[130] Elman, "Statecraft and Classical Learning." 354; Hu, *China's Transition to Modernity*, Chapter 7
[131] Guo Wu, "Zhang Zhen and the Rise of Evidential Research in Late Qing Northern Guizhou," *Journal of Chinese History* 2 (2018): 145–67., 154-156

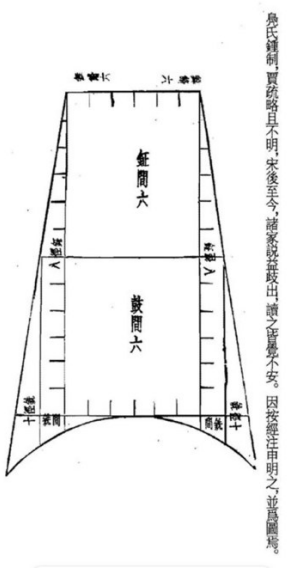

Figure 3-13: Illustration of Quantified Bell Measurement. There are several examples of technical drawings for ritual artifacts in the evidential literature. This example was drawn by Zheng Zhen in his analysis of Pre-Qin bells. The drawings provide multiple sets of measurements for reconstructing the shape and structure of the historical artifacts. Source: Wu, "Zhang Zhen and the Rise of Evidential Research.", 155

This was "ritual precision." It employed quantitative measurement to explain the parts of ancient artifacts and used detailed studies of language to reconstruct the ancient texts. The final goal of this precision was to purify Confucianism. In removing historical accretions and reconstructing ancient practice, these scholars used *kaozheng* methods. This evidential learning combined reconstructions on language and other "concrete" studies like astronomy to the past. By applying *kaozheng* methods, scholars sought to recover these rituals to improve social and moral cultivation. In the words of Ling Tingkan 凌廷堪 (1757-1809), "The Way of the sages is only ritual propriety."[132]

Ritual precision was not universally accepted. Fang Dongshu 方東樹 (1772-1851) criticized the Han learning movement in general, and he specifically targeted the reconstruction of ancient tools as foolhardy, that they were based on contested claims instead of true principles. Fang shared the widespread value toward using rituals, but he thought that scholars of evidential learning had moved too far from moral principles by treating small distinctions as the most important training.[133] They no longer followed the interpretation of the classics derived from Neo-

[132] Quoted in Chow, *The Rise of Confucian Ritualism in Late Imperial China*. 191
[133] Fang Dongshu, *Han Xue Shang Dui 漢學商兌* (Feng huang chu ban she, 2016). j. xia, 213

Confucian thinkers. Instead, they prioritized methodology as in rules and regulations. Yet these rules did not create shared understanding. When they reconstructed historical artifacts, they quibbled over individual facts. Even as they built specialties in measuring historical architecture, chariots, clothes, and more, their ideas disagreed with one another. "They do not know whose ideas represent true knowledge and discrimination."[134] While Fang agreed that it was important to identify historical materials to understand the classics, he believed that the focus on moral principles was a greater effort and needed to be first, otherwise, the priority of being right in one's specialty created selfishness and self-promotion instead of the principles of proper management and order.[135]

Ritual Precision of Zhang Zuonan

Zhang Zuonan's application of ritual precision with time instruments illustrates a middle ground in the emerging debate over Song-Learning and Han-Learning. Zhang was writing from Changzhou, the center of New Text Confucianism and *guwen* 古文 Ancient-style poetry. Although New Text Confucianism criticized Han Learning generally and promoted the Gongyang commentary, New Text Confucians still valued certain texts associated with the Zhou period, such as the *Yijing* 易經 *Classic of Changes* and the *Rituals of Zhou*. The founder of Changzhou's New Text scholarship Zhuang Cunyu 莊存與 (1719-1788) revered the *Rites of Zhou* as one of the classical sources for identifying the principles of the sage kings.[136] As the district magistrate, Zhang became embedded in the gentry networks that also advocated for this interpretation. Zhang Zuonan was directly involved with another local leader in the movement Zhao Huaiyu.[137] Similarly, even though biographies criticized Zhang for avoiding aspects of literati culture, Zhang's close friend Qi Yanhuai was enmeshed in the *guwen* poetry tradition. Qi had been a student of Yao Nai 姚鼐 (1731–1815), one of the leaders of the Tongcheng literary circle. This was the same group to which Fang Dongshu belonged.[138] After moving to Yixing 宜興, Qi

[134] 各自專門亦互相駁斥不知誰爲眞知定見. Fang, *Han Xue Shang Dui*., j. xia, 213
[135] Fang, *Han Xue Shang Dui*., j. xia, 213-215
[136] Benjamin A. Elman, *Classicism, Politics, and Kinship: The Ch'ang-Chou School of New Text Confucianism in Late Imperial China* (University of California Press, 1990),. 140
[137] Zhang, *Chuai Yue Xiao Lu*, Zhao Huaiyu preface, 1a-2b, Zhao Huaiyu second preface, 1a-2a; Elman, *Classicism, Politics, and Kinship*. 119-120, 125-127
[138] Lin, *China Upside Down*. 241-249

continued to be a part of the local poetry movement, maintaining his connections to poets in Changzhou.[139]

If critics regarded historical reconstruction as too literal, Zhang Zuonan therefore used sundial templates and trigonometry as a method to demonstrate how one could both reconstruct ancient practices for time rituals as well as update it for much wider application. Firstly, Zhang's arguments about latitude and longitude meant that he encouraged literati to use more precise definitions about their location in space to strengthen their approach toward the definition of time. Although local time could vary, Zhang wished to promote local times to align this time with ritual standards in Beijing. Zhang's focus on eclipse events, for example, makes it clearer that his purpose was about simultaneity.

Furthermore, although Zhang's treatise on sundials demonstrated how to build a sundial, Zhang viewed sundial drawing as the entry point into precision measurement in the sun's altitude and shadow measurements. Zhang's first treatise explained the mechanics of creating sundials. His second treatise expanded on the designs of horizontal and vertical sundials to illustrate how to calculate times with just a gnomon. He emphasized that there were two ways to fix gnomons: vertical and horizontal. By using trigonometric ratios, one could then measure the length of the shadow and know the hour. One could use these methods to also identify dates and periods in the year. As he explained, "I note that for a vertical gnomon [one that stands straight above the ground] use the cosecant adding the latitude angle to the sun's radius, and then take the measure of the shadow. For horizontal gnomons [one that is placed against a wall] use the tangent subtracting the latitude angle to the sun's radius and then take the measure of the shadow."[140]

Zhang and Jiang created several templates to illustrate other principles too. One case dealt with the problem of interruptions. Because the length of the shadow changed with the year, Zhang admitted that these methods were not always suitable. To make sure that these tools were portable, Zhang encouraged users to make small versions of these tools. They might be small, but the shadows would be larger. He suggested using angular measurements and reflections as a way to adjust and find seasonal variation.[141]

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[139] Anhui tong zhi guan, *Anhui Tong Zhi Gao 安徽通志稿* (1934), j. 157, 16a.; Lin, *China Upside Down*. 241-249; Lin, *China Upside Down*. 203-227; Rowe, *Speaking of Profit*. 119-126; Qi Yanhuai, *Meilu Shi Chao 梅麓詩鈔* (Sui an shi, 1875), Yale Library.

[140] 楠按直表用餘切以太陽半徑加高度而取直影橫表用正切以太陽半徑減高度而取倒影. Zhang, *Chuai Yue Xu Lu*. j. xia, 1a

[141] Zhang, *Chuai Yue Xu Lu*. j. shang, 24a-25b

Moreover, they built a set of unusual templates that were supposed to guide users to identify hours quickly (see Figure 3-14). According to the method, one should draw a circle and place the gnomon in the center. Then, one should divide the circle into twenty-six sections to represent the sun's apparent motion. By setting the length of the gnomon to one *cun*, the user needed to refer to the table. Since the table included the calculated length of a shadow for an hour in any seasonal period, one would therefore find one's respective latitude in the table and then draw and mark the lengths of the measurements directly on the line which matched the corresponding seasonal period. If one needed to know smaller divisions then an hour, one could continue to use trigonometric ratios to divide lengths into even smaller units and add them between the hours. To use this time-finding instrument, one needed to place a gnomon of the prescribed measurement in the center. After ensuring that the template plate was level, one would need to identify the related solar period. Then, they could adjust the line of that solar period to match the shadow. Where the shadow ended indicated the hour.[142]

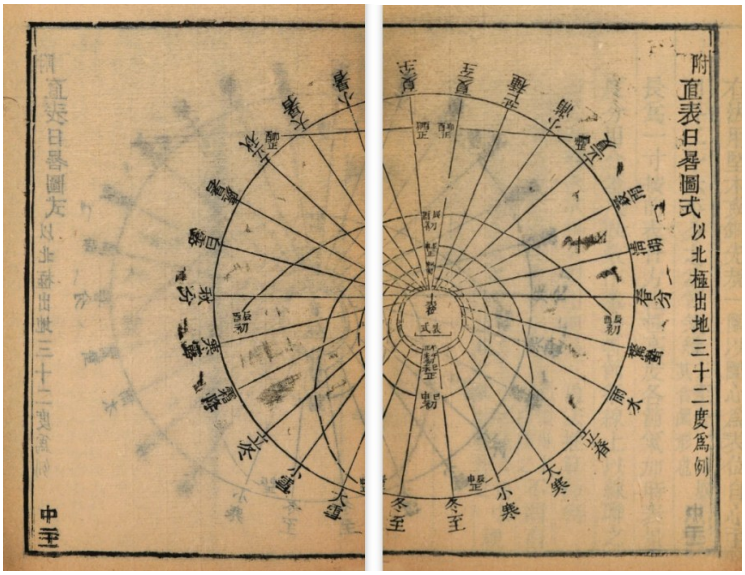

Figure 3-14: Zhang Zuonan's Horizontal Altitude Dial Diagram. This illustration is meant to provide a template for individual use. This altitude sundial is constructed for 32 degrees northern latitude. Zhang intended the model to be an exemplar by which one could adapt his instructions and create new versions for one's location.

[142] Zhang, *Chuai Yue Xu Lu*. j. shang, 22a

Similar to what is today called a horizontal altitude sundial, this template provided multiple affordances to users according to Zhang and Jiang.[143] The instrument incorporated classical models of the shadow lengths, but it was also calibrated using a table to any latitude in the empire. Furthermore, the diagram was small and portable. One could use it widely. Because it was based on the solar altitudes, it did not require one to align it with north or south. Moreover, Zhang and Jiang suggested that it could be made even simpler. Because the seasonal joints were symmetrical around the solstices, one did not need to list out all the joints. If one combined each line to represent two solar periods, one could then create a simplified version (See Figure 3-15).[144]

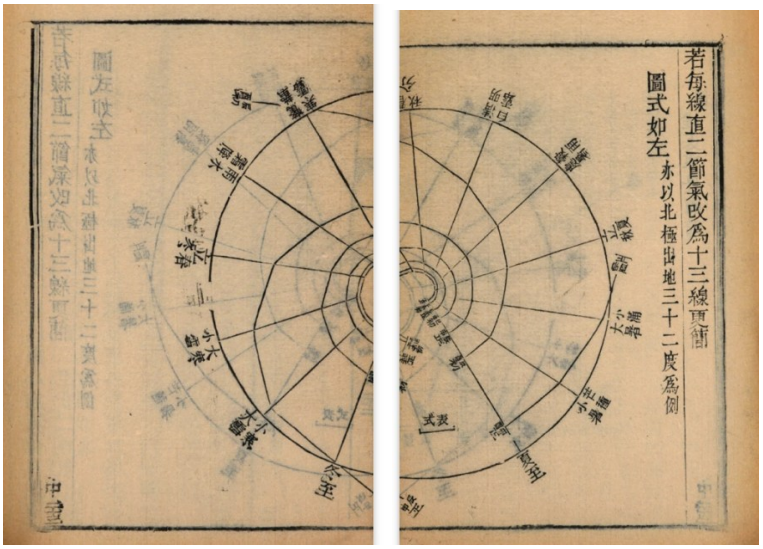

Figure 3-15: Zhang Zuonan's Simplified Altitude Dial Diagram. The simplified altitude dial doubled the seasonal joints. This model was constructed with the data for 32 degrees north latitude. Source: Zhang, Chuaiyue xulu. j. shang, 23a-23b

In addition to the horizontal altitude dial, Zhang and Jiang suggested using vertical altitude dials. In European literature, these sundials were called pillar dials and shepherd's dials, and they were early examples of portable sundials.[145] Zhang wrote about this type of sundial as a part of his

[143] Compare with Allan A. Mills, "Altitude Sundials for Seasonal and Equal Hours," *Annals of Science* 53, no. 1 (1996): 82.
[144] Zhang, *Chuai Yue Xu Lu*. j. shang, 23a-23b
[145] For additional notes on the context of altitude dials, see Mills, "Altitude Sundials for Seasonal and Equal Hours." 84; Claudia Kren, "The Traveler's Dial in the Late Middle Ages: The Chilinder," *Technology and Culture* 18, no. 3 (1977): 419–35; Mario Arnaldi and Karlheinz Schaldach, "A Roman Cylinder Dial: Witness to a Forgotten Tradition," secs. 107-117, *Journal for the History of Astronomy* 28, no. 2 (1997); Sara J. Schechner, "The Material Culture of Astronomy in Daily Life: Sundials, Science, and Social Change," *Journal for the History of Astronomy*

discussion on setting up a gnomon against a wall (see Figure 3-16). By using the same techniques of trigonometric ratios, one could make seasonal observations quick and easy. The time indication for such a ritual process was not limited to the kind of description in the classical sources, but if one understood the principles it would offer multiple modes of engaging with the techniques. The vertical altitude dial gave another tool which could be transported and accessed to make time-finding easier to use. Zhang even noted that one could copy the design of a vertical altitude sundial and draw it on a folding fan. If one were to add a small pin on the tassel of the fan, the fan would then become a sundial. "For collecting shadow measurements, it is most convenient." [146] Cylindrical objects were also possibilities. One simply had to look at the indication of the shadow to know the time.[147]

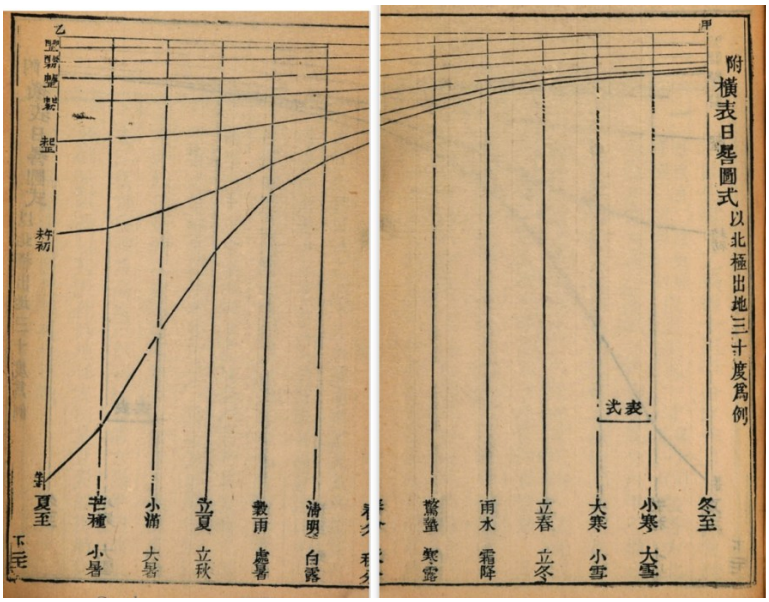

Figure 3-16: Zhang Zuonan's Vertical Altitude Dial Diagram. The vertical altitude dial was constructed for 30 degrees north latitude. The lines that stretch across the page and expand are the hour lines. The parallel lines on the bottom are the twenty-four seasonal divisions. Source: Zhang, Chuaiyue xulu. j. xia, 21a-21b

Consequently, this quality of ritual precision by employing repeated quantitative measurement and applying it toward state and public rituals explains why Zhang placed such a focus on creating two public, monumental sundials in Changzhou. The vertical and horizontal

32, no. 3 (2001): 212; Catherine Eagleton, *Monks, Manuscripts and Sundials: The Navicula in Medieval England* (Brill, 2010).

[146] Zhang, *Chuai Yue Xu Lu*. j. xia, 22a

[147] Zhang, *Chuai Yue Xu Lu*. j. xia, 22b

sundial illustrated the ritual elements of astronomical practice. But they also served as visual indicators to verify the geometric methods being used here. While the horizontal sundial reflected a more historical approach toward the ceremonies in finding noon, the vertical sundial demonstrated the geometric principles that could adapted for building new devices that enhanced the properties. I previously noted that the inscriptions explained magnetic variation and longitude. The two dials explained this in tandem. As noted in the horizontal sundial, the inscription stated that one could compare these sundials as an example of verification and testing. Both types of dials had affordances, and they both served as measurements for finding "celestial time". While they used different relationships to cast shadows to indicate time, they provided the same information that could be used for understanding and therefore performing rituals at the right time.[148]

Sundials and the broader set of tools used for measuring and indicating the time supported this ritual precision. These tools provided greater quantification to refine the practice of measuring the seasons. One could use these tools to divide the units of time into smaller measurements to identify the moments of transition with greater precision. At the same time, this attention to quantification made it possible to refine ritual in space. Now, one could conduct the rituals with the proper adjustment for a local place in comparison to the standard set in Beijing. Ritual precision encouraged a type of imperial level standardization through the management of time.

But this was not the only implication of this procedure. Creating precision at this level also meant the wider practice of rituals. These rituals were supposed to be state rituals. Although private rituals always included references to time and seasonal change, individuals had relied on the state communication system. But by conceiving of space and time together, local practices of time were out of sync. This was a problem of social order and required greater participation and inclusion for how to define management. As a result, financial measures and other forms of local activism also combined with theories of ritual control and ritual practice.

Ritual Precision as Governance

Zhang Zuonan put precision into action. Since Zhang was addressing a new kind of problem, he became an active educator and promoter for how to connect these roles. Zhang engaged with

[148] Pan Nai, *Colour Printing: The History of Ancient Astronomical Instruments of China 彩圖本：中國古天文儀器史* (Shaanxi jiao yu chu ban she, 2005), 110; *Wujin Tian Ning Si Zhi,* j. 5, 103.

popularizing science to educate audiences regarding the power of precision to control and manage society. Initially, Zhang used his talents to address his personal staff and the educated elite who were around him. Then, with the introduction of more serious crises, Zhang extended his reach. He used printing to publish his books and bring them to new readers, and he created instruments so that he could provide specific tools to practice precision. In other words, ritual precision was not simply about refining historical practices. It was also a ritualized process that had to be used to create the category of precision. It required qualities and a new identity around training and discipline to create this form of management.

Using Astronomical Methods to Solve Management Problems

Zhang Zuonan had already experimented with some of these strategies of gentry management and precision instruments when he worked as the educational commissioner in Chuzhou from 1813 to 1816. In that role, Zhang helped create a special training program in mathematics that was a part of new policies introduced in collecting and measuring grain. District magistrates frequently relied on local gentry in administration. These elites, which included a variety of landowners and degree-holders, represented local interests at sub-district levels. They were crucial intermediaries. The state depended on them for a variety of functions including grain collection, tax collection, and organizing local defense.[149] When the state tried to introduce more quantitative procedures in gathering grain, the policy required local managers to practice accounting. Since Zhang had already developed a reputation for mathematics, the county magistrate Tu Yizhou 涂以輈 (1755-1820) asked if Zhang would help him and his staff understand how they were supposed to implement the new reform policy. They inquired if Zhang could provide instructional materials that explained the new kinds of numeracy that were included in the policy reforms.[150]

This policy had its origins to 1812 when Ruan Yuan was appointed temporary grain tribute collector and implemented a clever application of sectors. By this year, Ruan Yuan had a reputation for innovative solutions to solve financial problems with local governments.[151] Ruan Yuan also

[149] Chung-li (Zhang Zhongli) Chang, *The Chinese Gentry: Studies on Their Role in Nineteenth-Century Chinese Society* (University of Washington Press, 1955). 48-51; Hsiao, *Rural China*. 96-97, 133-134; Ch'ü [Qu], *Local Government in China*. 180-185

[150] Zhang, *Mei Yi Sui Bi*. 57. There is another account that states that one of the members of the local gentry also reached out to ask Zhang to help. Zhang, *Mei Yi Sui Bi*. 55

[151] Wei, *Ruan Yuan, 1764-1849*. 339-340

had used his connections to reform-oriented political factions. These groups had supported his work and helped circulate his efforts in trying to find cost-effective techniques to implement financial reform.[152] Ruan Yuan was thus appointed to the temporary position as grain manager to resolve the problems of his predecessor. Following delays in grain shipments, the government had investigated and discovered that there were significant deficits in the grain shipments under the previous administrator. One of the biggest concerns was that the boatmen in the grain shipments were stealing grain from the shipments as it passed through the Grand Canal.[153]

Among Ruan Yuan's reforms, the most consequential for Chuzhou was a set of new rulers. This was an idea based on the mathematical tools Ruan Yuan had become familiar with during his time managing the Astronomical Bureau. These tools were offered as a solution to increase administrative efficiency and shorten the time spent on producing the accounts. The tools were proportional rulers and calculators. Ruan Yuan considered the tools more numerate and elegant. They were less easy to alter. The tools shifted the blame from clerks onto the overseers and managers who were responsible for the grain. In other words, the various managers, such as the local gentry and officials in Chuzhou, would now be held responsible for mistakes.

The calculations for submitting grain reports were tedious. When managers reported grain to the higher offices, they used volume measurements to report how much grain was transported. But each ship had a different capacity. This meant that grain managers relied on a large network of paid staff who had to determine how many compartments were on each boat, the size of the compartments, and the total amount of grain per boat.[154] Furthermore, because there were two different unit systems used for volume, the numbers were particularly confusing. The clerks had to conduct multiple sets of grain conversions as a part of the calculation process. This was a time-consuming task.[155]

To fix this problem, Ruan Yuan introduced something he called the *liangmi jiefa* 量米捷法 "quick method for measuring grain". How did it work? It was based on the principle of proportionality and followed a construction similar to a geometric or logarithmic series line. These were the types of lines or calculation rulers used in sectors. The new measurement method combined the proportions of the two systems of volume into a new conversion and attached it to a

[152] Wei, *Ruan Yuan, 1764-1849*. 41, 74-77
[153] Wei, *Ruan Yuan, 1764-1849*. 339
[154] Ruan, *Yan Jing Shi Ji*, vol. 1. Sanji 三集, j. 2, 8a, 611-612
[155] Ruan, *Yan Jing Shi Ji*, vol. 1. Sanji 三集, j. 2, 8a, 611-612

measure of length. By using the fact that the *dan* 石 volume was based on equal parts divided by ten, just as the system of length, the new set of rulers could solve volume problems faster. In a sense, this form of measurement tried to rationalize volume and weight much like with meters and liters.[156]

Before Ruan Yuan's intervention, managers had measured all three sides of the shipment compartments with a standard-length ruler in height, width, and depth. They multiplied these measurements to find the volume; and then, they converted these measurements into their equivalent grain volumes. The new ruler tried to reduce conversions. Instead of measuring each side, this ruler measured the ratio of length to volume within the new dimensions. For example, the standard *hu* 斛 container equaled half the volume of the standard *dan* 石 container. By doubling *hu*, one could produce a perfect cube that equaled the total volume of one *dan*. Using this volume, Ruan Yuan made one *chi* represent the length and width of the double-hu container. By producing ten *chi* of equal length, ten *chi* equaled one *dan*. Because volume in *dan* was based on ratios of ten, one *zhang* of this ruler could be equated to *dan*, one *chi* to *sheng*, and so on.[157]

In practice, it simplified multiplication in converting between different units. Now one could measure the three sides, record their units in length, multiply them together and the total in *zhang*, *chi*, *cun*, and *fen* would equal the volume.[158] Ruan Yuan added that if one combined the method with lattice multiplication, it would speed up the process. Lattice multiplication was a type of pen-based arithmetic, whereby the user created a grid of the two factors to be multiplied. It

[156] On the one hand, liters were defined in terms of cubic meters. Yet there are significant differences in the contexts here. Metric reformers were interested not just in rationalization through decimals and equivalences, but they were focused on standardization. It is worth noting that Ruan Yuan's procedures were not targeting the diversity of weights and measures that defied simple standardization. Also, Ruan Yuan's lengths were linked to state rulers. In other words, the Qing context here had a significant philosophical difference insofar as Ruan Yuan relied primarily on state authority as an explicit model whereas the political rhetoric of the metric system tried to frame standardization and rationalization as claims toward nature. For more context on the metric system, see John L. Heilbron, "The Measure of Enlightenment," in *The Quantifying Spirit in the 18th Century*, ed. Tore Frängsmyr et al. (University of California Press, 1990). 207-243; Charles Coulston Gillispie, *Science and Polity in France: The Revolutionary and Napoleonic Years* (Princeton University Press, 2004). 223-285; Ken Alder, "A Revolution to Measure: The Political Economy of the Metric System in France," in *The Values of Precision*, ed. M. Norton Wise (Princeton University Press, 1997). 39-71

[157] Ruan, *Yan Jing Shi Ji*, vol. 1. Sanji 三集, j. 2, 8b, 612

[158] Ruan, *Yan Jing Shi Ji*, vol. 1. Sanji 三集, j. 2, 8b-9a, 612

reduced the effort in writing addition underneath the two factors by adding the numbers across diagonals instead (see Figure 3-17).[159]

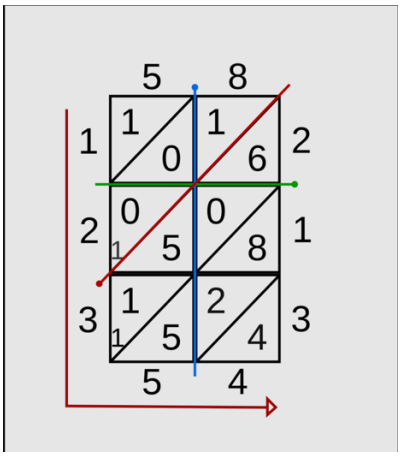

Figure 3-17: Visualization of Lattice Multiplication. Lattice multiplication is a diagonal method of multiplication and addition. This image illustrates the completed lattice multiplication for multiplying 58 by 213. Each column is separated by a diagonal; then, one adds all the corresponding numbers in the diagonal to produce the final result which is written outside the boxes from the top down to the bottom right. Source: Wikimedia Commons

Ruan Yuan distributed the new rulers to grain collection sites along with his corresponding pamphlet. He explained that the purpose of the rulers was twofold: to replace the use of the abacus and encourage managers to review the accounts. The new method was fast and reliable. And, in his view, simple to understand. The abacus, in contrast, could not be trusted, because it was too easy to move a bead in the process of calculation.[160] Pen-based mathematics and rod-based mathematics (which were similar to the grid technique he proposed) created permanent records that were easier to check.[161] The method also encouraged managers to increase their oversight. Although the grain tribute regulations stated that managers were supposed to review the numbers calculated by their staff, it did not provide much guidance on what they were supposed to do. Grain managers also tended to avoid their responsibility because they found abacus calculation cumbersome with all the rules and procedures necessary to become an expert with it.[162] But

[159] Although long-form multiplication was introduced with the missionaries, lattice multiplication had a long pedigree in China as a type of quick solution for mathematics. Wu Jing, *Jiu Zhang Xiang Zhu Bi Lei Suan Fa Da Quan 九章詳注比類算法大全*, Xuxiu Siku Quanshu 續修四庫全書 1043 (1450). Qili, 21b-22b, 549

[160] Ruan, *Yan Jing Shi Ji*, vol. 1. Sanji 三集, j. 2, 9a, 612

[161] Ruan, *Yan Jing Shi Ji*, vol. 1. Sanji 三集, j. 2, 9a, 612

[162] Ruan, *Yan Jing Shi Ji*, vol. 1. Sanji 三集, j. 2, 8b, 612

according to Ruan Yuan, pen and rod-based techniques were more appropriate for managers. This method used the tools of the scholar: paper, pen, ink. "We Confucians study numbers through their written form. In the end, for us using brush and ink is more suitable. To use an abacus tray is not in our nature."[163]

In sum, this new policy shifted some of the responsibility from staff to management. One could not use the excuse that it took a long time to review all the accounts and that one did not know how to use the abacus well enough. Grid mathematics was simple to understand and could be applied after just a short period of time. Ruan Yuan's explanation is worth quoting in full.

> If the Grain Commissioner has evidence (ju) for his knowledge regarding the reality (shi) of how much surplus he has and how much he lacks, then all the support staff of the military and government offices would not dare to deceive him. Furthermore, if he commands his staff employees to study and use the abacus to calculate, he can use this pen-based arithmetic to review their calculations. Moreover, it could not but be true, if a clerk had spent ten ke (five hours) of work with an abacus and the old ruler to measure ten ships, with this ruler and an abacus, it would only take about five or six ke (about three hours) to determine the accounts. This would indeed please the clerks due to its convenience and speed. Not only that, the grain ships would also find it convenient and expedient to use these special rulers to calculate the grain.
>
> 若總漕有實，知其多實，知其少之據，則營衛軍吏，皆不敢欺矣，且即令吏人習用珠盤者算之，而總漕用此筆算抽察之，亦無不可，假如吏人珠算舊尺十船，須用十刻工夫者，此尺珠算五六刻，即可得數，是吏人亦樂此便捷也，不第船也，即特此尺量倉穀，亦便捷焉.[164]

Ruan Yuan reframed this issue as one of efficiency. The problems of misallotted grain were a problem of oversight. By introducing a method that simplified the time, managers could no longer blame their clerks to be the only person responsible for the problem. Ruan Yuan anticipated a counter-argument. While a literatus might claim ignorance of accounting because abacus reckoning was associated with clerks and merchants, Ruan Yuan introduced the tools that were

[163] 吾儒習書數終以筆墨為便與珠盤性不相近也. Ruan, *Yan Jing Shi Ji*, vol. 1. Sanji 三集, j. 2, 8b-9a, 612
[164] Ruan, Yan Jing Shi Ji, vol. 1. Sanji 三集, j. 2, 9a-9b, 612-613

associated with the classical scholar. These were pen and paper tools. Moreover, they related to the kinds of historical bamboo rods further revered by classical scholars. Ruan Yuan argued that mathematical skills and numeracy were not simply the work of merchants and clerks. They were precision tools that helped literati and scholar-officials identify corruption and manage workers.

After promulgating these instructions along with the model rulers, Ruan Yuan now expected that local officials would exercise greater control over the calculation and reporting process. But the leaders in Chuzhou recorded one of the few reactions to this new tool. According to the stories from Chuzhou, people thought it was clever to have a device that could help simplify the process of determining the amounts of grain supply, but they did not understand how it worked.[165] This was why Zhang became involved in trying to create a set of elementary handbooks that could be distributed for it. Zhang was considered an ideal candidate to help with this, because he was already working on projects related to historical metrology.[166]

Zhang helped explain the principles behind the ruler and showed why these tools were efficient tools of calculation. He created the textbooks with a broad reader in mind. He imagined that the individuals had little background in mathematics, and Zhang targeted his books toward community leaders who were not a part of the bureaucracy. In order to make the instruments clearer, Zhang connected the rulers to the concepts of calculation techniques associated with the astronomical bureau and making calculation more efficient.[167] For instance, these textbooks expanded the concept of proportion to other types of pen-based mathematics. This was how Zhang started to introduce general audiences to the techniques of algebra from both the Chinese and Western traditions. In addition to the general introduction to measurement then, Zhang also provided new textbooks that explained the two types of algebra and how to work with unknowns.[168]

These techniques were meant to have wide application. At first, Zhang started with the specific examples related to grain conversions. But by teaching the mathematics associated with proportions, Zhang also explained that the principles could be applied to land units too. In other words, he helped clarify how specialty calculation devices could simplify not just grain taxation,

[165] Zhang, *Mei Yi Sui Bi*. 55; Zhang Zuonan, *Liang Cang Tong Fa 量倉通法*, CWSFSX (1820). j. 1, 1b
[166] Zhang, *Mei Yi Sui Bi*. 62-64
[167] Zhang, *Mei Yi Sui Bi*. 55; Zhang, *Liang Cang Tong Fa*. j. 1, 1b
[168] Zhang, *Mei Yi Sui Bi*. 55 ; Zhang, *Liang Cang Tong Fa*. j. 1, 2a ; Zhang Zuonan, *Cang Tian Tong Fa Xu Bian 倉田通發續編*, CWSFSX (1820). j. shang, 1a-1b; Zhang, *Mei Yi Sui Bi*. 56

but they could also apply to land taxes and other types of unit problems that were of interest to local elites.[169]

Astronomical Tools, Rituals, and Public Spirit

Zhang Zuonan helped popularize mathematical tools as the new tools of literati much wider than the context of grain management. After moving to Jiangsu province, Zhang became increasingly involved in other forms of crisis management in which he tried to connect astronomical and mathematical tools of precision as means of social reform. He continued his efforts at popularization to change literati ignorance into a kind of enlightened manager. These efforts particularly targeted the notion that upright community members needed to share the burden of leadership through this idea of "public spirit" and community support.

Zhang explicitly participated in the effort with what he called a "public spirit" to rally wealthy individuals and local leaders outside of the government to contribute and support the government in a time of crisis.[170] During the heavy rains in 1823, the floods damaged the fields, roads, and channels in Taicang Prefecture. Local gentry asked Zhang to dredge new drainage lines, because this region held one of the most important waterways connecting Suzhou to the ocean. Yet, with funds running low, Zhang could not access government funds. Instead, he created an arrangement with the local merchants to release private security funds to pay for the repairs.[171] In his request, he explained that the work was expensive but necessary. The total cost amounted to 7818 liang 9 qian, with more than 6000 dedicated to supplies and another 1000 dedicated to labor costs.[172] Zhang wrote that employing the investments would have benefits. Since so many were out of work and local security was in danger, the project would bring the community together.

[169] Zhang, *Mei Yi Sui Bi*. 56

[170] This idea of public and private has generated a debate over the terms public sphere and civil society. On the one hand, Zhang's activities belonged to an earlier form of gentry activism that promoted participation and community involvement. These arguments were based on the notion of duty towards others rather than defined by profit. For an introduction to this debate in the literature, see Mary Backus Rankin, "The Origins of a Chinese Public Sphere: Local Elites and Community Affairs in the Late Imperial Period," *Études Chinoises* 9, no. 2 (1990): 13–60.; William T. Rowe, "The Public Sphere in Modern China," *Modern China* 16, no. 3 (1990): 309–29.; Frederic Wakeman, Jr., "The Civil Society and Public Sphere Debate: Western Reflections on Chinese Political Culture," *Modern China* 19, no. 2 (1993): 108–38.; William T. Rowe, "The Problem of 'Civil Society' in Late Imperial China," *Modern China* 19, no. 2 (1993): 139–57.; Philip C. C. Huang, "'Public Sphere'/"Civil Society" in China?: The Third Realm between State and Society," *Modern China* 19, no. 2 (1993): 216–40.

[171] *Taicang Zhou Zhi* 太倉州志, Airusheng (1919). j. 5, 21b-22a

[172] *Taicang Zhou Zhi*. j. 5, 21b

With these funds, "the waterways will avoid blockages. Then, by using the strength of the people, we will benefit the affairs of people and feed the mouths of the people."[173] According to the local gazetteer, this effort was so successful that by the ninth month they had drained much of the overflow and were able to have some harvest.[174]

This idea of "public spirit" or *gong* 公 impacted the community in a variety of different modes. For instance, Zhang helped raise funds from community members to rebuild the local Confucian academy because it was damaged following the floods.[175] He also guided gentry leaders to organize and manage local militias. According to Shao Tinglie 邵廷烈 (fl. 1823-1839), a landholder in the Taicang countryside, people were anxious after the floods. Since the damage was far greater than anything previously experienced, the general population was especially concerned that the disaster indicated something more severe than just rain. Besides political uncertainty, there were also immediate concerns over banditry and pillaging from the high numbers of displaced people. Zhang helped organize security teams to guard the city.[176] He helped organize charity donations to supplement the state's famine relief funds. In Shao Tinglie's view, these efforts at security and public defense were key factors in why many people participated in dredging and trying to deal with the damage so quickly. Local elites consequently praised Zhang and the other local officials under his authority. "These officials loved the people like a virtuous parent. They valued righteousness like the sages. The values of these leaders were sufficient to suspend into eternity."[177]

These policy choices that brought public figures into government shaped the emerging new forms of gentry activism that focused on crisis management. By incorporating local gentry into government management, Zhang Zuonan started to implement the idea of collective governance and local autonomy in finances that his friend and fellow official Qi Yanhuai had published and circulated just a few years prior to the disasters. During Qi's own period of service in Jiangsu, he developed a policy solution for disaster relief that he called *tuzhen fa* 圖賑法 "method to map out disaster relief." The concept was related to other policy initiatives that circulated among local elites

[173] 水道既免壅阻而用民之力利民之事并可餬民之口. *Taicang Zhou Zhi*. j. 5, 22a
[174] *Taicang Zhou Zhi*. j. 5, 22a
[175] Zhang, *Zhang Zuonan Nianpu*.165-167
[176] Shao Tinglie, "Si Jiu Ji Lüe 飼鳩紀略," in *Zhongguo Huang Zheng Shu Ji Cheng 中國荒政書集成*, vol. 5, ed. Wenhai Li et al. (Tianjin gu ji chu ban she, 2010). 3089
[177] 慈父母之愛民，諸君子之好義，皆足以垂不朽. Shao, "Si Jiu Ji Lüe 飼鳩紀略." 3089

in Jiangsu and Zhejiang as ideas to implement fiscal reform, improve public welfare, and incorporate public and private partnerships in governance. They went by a variety of different names, including *yizhen* 義賑 "virtuous disaster relief" and *xiangzhen* 餉賑 "disaster relief and aid". What these policies all had in common was that they offered new forms of financial arrangements such that local landholders could participate in managing and distributing funds for community care while maintaining control over the finances, generating official policies below the level of the district magistrate yet that were also grounded in local communities.[178]

Although local gentry had long practiced charity donations as a demonstration of public virtue, the *tuzhen fa* created new mechanisms and incentives that generated widespread enthusiasm for the design. Most earlier charity projects had been controlled by the prefectural or district magistrate as a state-sponsored project. Individuals were supposed to contribute to the state, and then the state determined who needed the support and its distribution.[179] The *tuzhen fa*, however, mapped out relief funds by territory at a level beneath that of the district. It allowed the community to determine how to distribute the funds in an emergency on its own terms. Sub-district regions were divided by villages and communes. Each community appointed a local manager who tracked the collective funds for that territory. To prevent against corruption or one manager controlling the joint aid, the accounts were made open to the public. So, everyone in the community knew who had donated and how much. The concept was to use competition as a means of social responsibility and collective action. By making all the information available and subject to public scrutiny, each community member knew who had shown "public spirit" and who had not.[180]

Through a rather unique combination of shame and fame, this structure offered a tacit approval for profit and showmanship at the same time as demonstrating virtue and showing care

[178] Han, *After the Prosperous Age*. 78-80

[179] Earlier models included template donations, school buildings, dike repair, and other publics work projects. These structures had historical precedents and started to transform in intensity during the 19th century. For the broader historiography on this topic, see R. Keith Schoppa, *Chinese Elites and Political Change: Zhejiang Province in the Early Twentieth Century* (Harvard University Press, 1982).; Raymond David Lum, "Philanthropy and Public Welfare in Late Imperial China (Canton, Kwangtung, Charity)" (Phd Dissertation, Harvard University, 1985).; Mary Backus Rankin, *Elite Activism and Political Transformation in China: Zhejiang Province, 1865-1911* (Stanford University Press, 1986).; Timothy Brook, *Praying for Power: Buddhism and the Formation of Gentry Society in Late Ming China* (Council on East Asian Studies, 1993).; R. Bin Wong, "Benevolent and Charitable Activities in the Ming and Qing Dynasties: Perspectives on State and Society in Late Imperial and Modern Times," *Revue Bibliographique de Sinologie* 18 (2000): 249–58.; Joanna Handlin Smith, *The Art of Doing Good: Charity in Late Ming China* (University of California Press, 2009).

[180] Xu Dong, "Mu Ling Shu 牧令書," in *Guan Zhen Shu Ji Cheng 官箴書集成*, vol. 7, ed. Guan zhen shu ji cheng bian zuan wei yuan hui (Huangshan shushe, 1997). Qi Yanhuai, Tuzhen fa 圖賑法, j. 14, 28a-30a, 309-310

for one's community. Many families were eager to participate, because it offered a framework of charity through public-mindedness, and it offered a way for wealthy families to gain control over public finances.[181] Unlike other civil society institutions, these funds were defined as emergency organizations. They were intended to be used only for a set period and as a stop gap to deal with the state's declining fiscal capacity. But local sources indicate that the ongoing problems generated enthusiasm to keep these organizations running beyond their initial timeframe. Some contributions were so successful for some villages that they reinvested the funds into local pawnshops. The distributions empowered local families. Many of the local elite were involved in these credit institutions.[182]

The famine and floods of the 1820s accelerated the adoption of these types of endeavors for local gentry. These ideas had started to emerge during the 1810s. The state struggled to raise funds to deal with the White Lotus Rebellion and then the Eight Trigrams. Because the government was strapped for cash, local magistrates faced cash and grain shortages. As a result, these kinds of joint policy solutions offered a compromise insofar as locals took on the responsibility to cover charity and disaster relief while the government granted authority to the managers to be representatives of the public-private partnerships. Then, these kinds of public-oriented projects expanded in the following decades. They spread throughout Jiangnan and even into some northern regions as officials moved around the region, copied each other's models, and shared these ideas with each other. By the 1820s and 1830s with multiple environmental disasters impacting large swathes of coastal and northern China, these types of solutions also reached even greater audiences. They met an immediate need to provide resources to local communities faster, and they encouraged communities to practice virtue and care for each other.[183]

Zhang Zuonan promoted astronomical tools and knowledge alongside these fiscal solutions to circulate useful knowledge as another practical tool that could resolve contemporary problems. His treatises on logarithms, sundials, and time management were all compiled during this period

[181] Yuqing Chen, "Why Donate: The Famine Relief Sponsorship in Qing China," *The Chinese Historical Review* 31, no. 1 (2024): 56-80

[182] Yao Guangfa and Bo Run, eds., *Songjiang Fu Xu Zhi Guangxu 9 松江府續志 光緒 9* (1883), National Lbrary of China. j. 14, 6a-6b

[183] Yao and Bo, *Songjiang Fu Xu Zhi*. j. 14, 6a-6b; Wang Fengsheng, "Huang Zheng Bei Lan 荒政備覽," in *Zhongguo Huang Zheng Shu Ji Cheng 中國荒政書集成*, vol. 5, ed. Wenhai Li et al. (Tianjin gu ji chu ban she, 2010). j. xia, 3027; Pierre-Étienne Will, *Bureaucracy and Famine in Eighteenth-Century China*, trans. Elborg Forster (Stanford University Press, 1990). 314-315; Chen, "Why Donate." 62, n. 46

of crisis. The books all focused on techniques of useful knowledge. The material on logarithms and spherical trigonometry was meant to demonstrate the principles of local precision measurement and calculation tools to provide more efficient processes of quantification. Contrary to the specialists in mathematics, Zhang tried to make multiple techniques useful regardless of their specific origins. Anticipating criticism, Zhang explained that practical consequences were the most significant when dealing with Western and Chinese forms of algebra. He wrote, "What is important in talking about methods is precision (mi). Why should we divide between the past and the present? What is important in talking about calculation is efficiency. Why should we debate if it is Western or Chinese?"[184]

Similarly, in the case of logarithms, these Western forms of efficiency helped make the difficulty of spherical trigonometry more manageable. Those who commented on Zhang's writings explained that Zhang helped translate it effectively for the uninitiated. For instance, Qi Yanhuai compared Zhang's approach to other mathematicians. Mei Juecheng 梅穀成 (1681-1763) had used logarithms, but his texts were not elementary. Dai Zhen too had also tried to advocate for more spherical trigonometry in classical training, but he used unusual terms that made his texts difficult to follow.[185] Zhang, however, connected his learning within the practical tradition associated with the astronomical bureau. Since the bureau preferred to use logarithms, this was a way to make calculation less difficult. Zhang himself also praised Jiang Lintai's work, writing, "The tables of logarithms set up the tables of the trigonometric ratios. To talk about spherical trigonometry and not include logarithms is to avoid what is easy just to make it difficult. This is not the way to bring in future learners."[186]

Because Zhang redefined his audience as one of educated learners who sought useful knowledge, he concentrated his efforts on bringing multiple layers of gentry into his sphere. Zhang was not simply targeting the highest echelons of Chinese society. Rather the educated audience here was framed as a broad learner who needed practical knowledge. In his preface in support of Zhang's efforts, Qi Yanhuai described it this way.

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[184] 法取其密何分今古算取其捷何問中西之論. Zhang, *Hu Jiao She Ru*. Zhang Zuonan preface, j. shang, 1b

[185] Dai Zhen's terms were particularly controversial among late 18th and early 19th century mathematicians. For more, see Chen, "The Evolution of Transformation Media in Spherical Trigonometry in 17th- and 18th-Century China." 84-104

[186] 對數表為八綫設談弧三角而不及對數是舍易就難非所以引誘來學也. Zhang, *Hu Jiao She Ru*. Zhang Zuonan preface, j. shang, 1a

> The volume and the book containers are not ornate. Even the poor can afford it. The words are not opaque. Even the dull-witted can penetrate it. For those who study it, they can all obtain this book. If they read it, then they all can know the coordinate degrees of the ecliptic and the equatorial. This book raises what Dai Zhen kept mysterious and makes it a transmission of lost knowledge. It now publicly known in an instant. Is this not a wonderful thing for everyone? Hence, to peer into Zhang Zuonan's book is to know the character of Zhang Zuonan.
>
> 卷帙不繁，雖貧者易購，文字無障，雖鈍者能通，使學者皆得是書，讀之則皆可以知黃赤經緯之度，舉東原所秘為絕學者，一旦而公之，人人非大快事哉，故觀丹邨之書，知丹邨之為人.[187]

These books were useful and affordable. Since these materials were appearing at a time of significant constraint, Qi praised Zhang for making this mathematical and astronomical information accessible to a wide range of learners in terms of language and style as well as the actual costs of the books prepared.

This focus on practicality and usefulness did not just characterize mathematics, but it was also a part of learning time management. Zhang provided instructions in sundial making so that other readers would learn how to build their own.[188] One such reader Zhao Huaiyu 趙懷玉 (1747 — 1823) recorded how he used the tools and how they connected to bureaucratic management. Zhao was a retired official himself. He was not an expert in mathematics, but his grandson Zhao Zhuangmin 趙莊敏 (fl. 1820) was "known to Zhang" and brought the book home.[189] After reading the treatise, Zhao started to appreciate the mathematics of timekeeping. He had previously only thought that hours and days were important. Now he not only understood how to divide hours into smaller units of minutes and seconds and why these units were important for understanding local time.[190] Then, Zhao explained that this emphasis on detail was the kind of practical treatise that society needed at that time. He added that many Confucian scholars viewed practical mathematics like this as necessary only for military expansion and defense, but Zhao believed that these treatises were important during times of peace as well because they were

[187] Zhang, *Hu Jiao She Ru*. Qi Yanhuai preface, j. shang, 2a
[188] 爰臚作晷諸法於前並附此圖於後俾人人可仿製焉. Zhang, *Chuai Yue Xiao Lu*. 52b
[189] Zhang, *Chuai Yue Xiao Lu*. Zhao Huaiyu preface, 1a
[190] Zhang, *Chuai Yue Xiao Lu*. Zhao Huaiyu preface, 2a

important for knowing how to manage one's staff and ensure the proper connections between the local yamen and the wider community.[191]

After receiving one of Zhang's circular dials, Zhao further praised Zhang's designs and declared that these tools were especially practical for the empire. Zhao Zuangmin helped him set up the dial at home. They then used their local latitude to arrange the dial. Zhao Huaiyu could then look and see it, and he was able to identify its precision. They had previously used a sundial, but it was only good for a space of about 200 li. The new round dial was far more accurate (lit. divinely accurate *shenzhun* 神準). Zhao was amazed that the latitude-adjustment was so easy to use and made the dial capable to operate in remote places of the empire such as Mongolia.[192] "Who could compare to this without having studied the classics of the heavens or having knowledge that goes beyond the common man?"[193] The tool embodied the connection between man and heaven as described in the *Book of Changes*.

Moreover, through its precision and universal application, this sundial illustrated good statecraft. It showed the possibilities that might come from using technical skills in combination with government management. Zhao lamented that in their time, people of talent struggled to make success. Zhao cited two other mathematicians from the region. These were Dong Youcheng 董祐誠（1791-1823）and Zhang Chengsun 張成孫 (1789-?).[194] Like Zhang Zuonan, Dong Youcheng and Dong's student Zhang Chengsun were highly regarded mathematicians. They were involved in the study of Chinese algebra. Dong had published several studies on ellipses and curves in addition to some classical scholarship on the Yuan calendar.[195] But Dong's talent did not translate to significant material and social gain. As Zhao described it, Dong and Zhang struggled to cultivate a wider audience outside of mathematicians, because their work lacked such a focus on precision and practical management. They would have been more successful if they had studied with Zhang Zuonan and received his instruction concerning the translation of technical expertise to practical skills and useful knowledge.[196]

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[191] Zhang, *Chuai Yue Xiao Lu*. Zhao Huaiyu preface, 2b
[192] Zhang, *Chuai Yue Xiao Lu*. Zhao Huaiyu additional preface, 1a-1b
[193] 非具經天之學過人之智孰能與於此哉. Zhang, *Chuai Yue Xiao Lu*. Zhao Huaiyu additional preface, 1b
[194] Zhang, *Chuai Yue Xiao Lu*. Zhao Huaiyu additional preface, 2a
[195] For their biographies, see Luo, *Chou Ren Zhuan Xu Bian*, vol. 516. j. 51, 17a-22b, 512-514
[196] Zhang, *Chuai Yue Xiao Lu*. Zhao Huaiyu additional preface, 2a

Local Time and the Rituals of Private Security

Zhang Zuonan therefore advertised astronomical tools as benefits to practical problems. He linked astronomical tools to grain transportation, and he connected timekeeping to the wider practice of gentry management. One of the most concrete ways that Zhang connected astronomy and timekeeping with local government was through local security. By promoting greater attention to finding time at night, Zhang encouraged greater control over the security guards and city night's watch.

Although Zhang wrote several volumes on sundials, Zhang devoted most of his writing about time to finding and tracking hours of the night. He introduced the same passion for precision that accompanied his views of seasons and days with regards to the night. In his prefaces to these works, Zhang stated that he was writing for literati and scholars. But since local elites were one of the most significant social figures in managing the watchmen and in setting up security forces, this would have been the audience that he was targeting.[197] Moreover, Zhang compiled all of his treatises on finding time at night during 1823 at the same time as the Great Flood and when other sources claim that he was working with local gentry on building new types of security forces. While Zhang never stated explicitly that the goal of these treatises was about increasing control, it is reasonable to infer that Zhang must have wished to make this information more widely known as a part of his larger efforts to increase security.

The treatises on keeping track of time at night followed a similar logic as his other work on time and space. Firstly, building on the goal to define time by locality, Zhang encouraged his readership to pay attention to the local time for meridian measurements. While the state calendars printed some of the times for setting up water clocks at public stations, these works were only calibrated for prefecture or provincial seats. Zhang, however, introduced procedures to adjust time scales for any locality. For instance, he stated that if a local official were to use the reported night hours listed for Beijing, the official would be adding longitude errors into the times for that locality.[198] To illustrate the problem and help local officials, Zhang therefore created tables that

[197] Local gentry were included in *baojia* organization, but they were technically kept apart from the management of the *baojia* which remained under the control of commoners. But local elites and influential households were often de facto leaders in the community and came to exercise significant influence within these networks, either subverting them or using their local prestige to gain dominance over these security forces. Moreover, while they were not supposed to manage the *baojia*, local gentry were directly involved in organizing militia forces called the *tuanlian* 團練 which further increased their local sources of authority, especially from the mid-19th century onward. Chang, *The Chinese Gentry*. 66-68; Ch'ü [Qu], *Local Government in China*. 150-154, 183-186; Hsiao, *Rural China*. 67-72

[198] Zhang Zuonan, *Geng Lou Zhong Xing Biao* 更漏中星表 (1823). Zhang Zuonan preface, 1a

were adjusted for latitude and longitude and which were available to different consumers. Two of the tables were calibrated for large geographic areas, one for Jiangnan and another for Zhejiang province. He also created another special set of time data for his hometown in Jinhua prefecture.[199] Then, in addition to space, Zhang created increasing units of precision. Similar to his tables used for general reports of hours, Zhang added smaller divisions of time as standards that increased the level of observation for these tables. This meant that one had to use closer observations to measure the time down to minutes and seconds instead of simply relying on hours.[200]

Similar to his teaching how to build sundials, Zhang focused on explanations with all these tools to remove ignorance, because misunderstanding about natural phenomena could result in the community's lack of faith in the government. Most scholars and literati were unaware of astronomical tools. This was a social problem. Their ignorance created errors in measuring for these types of local functions of government. Astronomical phenomena, such as the annual precession or longitudinal difference, created small margins of error, but they compounded over time if one did not account for them. Although the government published data for large units, Zhang argued that individuals needed to learn the techniques and knowledge so that they could use the published material and then fill in the gaps for their specific locale and community.

> Those who are not government officials have not visited the Astronomical Observatory. They have not seen the rare books that are kept there. They always use outdated maps and illustrations to try to make verified observations. But when the observations do not match their expectations, they start to have doubts.
>
> 而草野之士，足未履觀象臺目未睹中秘書，往往執舊圖以驗今測，而疑與垂象不符者.[201]

What Zhang meant was that precision and observation were linked with trust in the state and its security. If observations appeared not to align with predictions, then the community might lose faith in the government. If the calendar seemed so out of sync, perhaps there were issues. But as

[199] Zhang Zuonan, *Jiang Nan Geng Lou Zhong Xing Biao 江南更漏中星表*, CWSFSX (1823).; Zhang Zuonan, *Zhe Jiang Geng Lou Zhong Xing Biao 浙江更漏中星表*, CWSFSX (1823); Zhang Zuonan, *Jin Hua Gui Lou Zhong Xing Biao 金華晷漏中星表*, CWSFSX (1823).
[200] Zhang, *Jiang Nan Geng Lou Zhong Xing Biao*.
[201] Zhang Zuonan, *Xin Ce Heng Xing Tu Biao 新測恆星圖表*, CWSFSX (1823). Zhang Zuonan preface, 1b-2a

Zhang emphasized by his frequent citations to the imperial textbooks in astronomy and mathematics, this was not an issue of the imperial calendar but rather an issue of widespread ignorance. Plus, consider that Zhang wrote this in 1823. He wrote amidst natural disaster. Popular sentiment would have treated natural disasters like the flood and eclipse as serious political warnings.[202]

Based on Zhang's reports, some local gentry were also begging for this information to help them conduct their work in their communities and make sure that they were responding to such errors. In 1821, after several readers in Zhang's network had access to his books on sundials, they sent requests asking him to help create more detailed material that was calibrated for their places. The calligrapher Zhou Xiangrong 周向榮 (fl. 1819-1823), who had previously served as an intermediary connecting Zhang Zuonan and Fan Jingfu, sent a message to Zhang.[203] He was based in Hangzhou which was located at 30 degrees latitude and 17 minutes. With a whole degree difference between Changzhou and Hangzhou, he asked if Zhang could create tables which could be used for thirty degrees.[204] Not long after, "enthusiasts" *haoshi* 好事 in astronomy and mathematics from Changzhou made similar requests. They wanted to have tables for many other locations throughout Jiangnan. These included cities like Suzhou and Taicang as well as Huai'an 淮安 and Haizhou 海洲 which all lay at different latitudes.[205]

Similar interactions occurred with Zhang and the gentry back in Jinhua. During 1823, Jinhua gentry tried to work with his latitude tables to create charts and tables. They sent a draft back to Zhang to ask him to review their calculations. Unfortunately, they had made errors in adjusting for their local site. Zhang explained that they needed to incorporate both geographic differences and the annual precession in their calculations. These slight adjustments would show how the view of the meridian changed slightly each year, and they would be able to more accurately incorporate their local time to check these transits. Zhang sent a new set of tables which

[202] Note that theories of time were included in Buddhist scriptures and millenarian change. For instance, in some books of Buddhist millenarian society, they described the three ages as having three different time systems for the months in the year, the days in a month, and even the hours in the day. For more about rebellion and timekeeping, see Naquin, *Millenarian Rebellion in China*. 11-12, 16-18; Wang, *White Lotus Rebels and South China Pirates*.
[203] For a brief entry on Zhou as a calligrapher, see Li Fang and Ye Mei, eds., *Huan Qing Shu Shi 皇清書史*, Cong Shu Ji Cheng Xu Bian 38 (Shanghai shu dian, 1970). j. 21, 11b, 196
[204] Zhang, *Gao Hu Xi Cao*. Zhang Zuonan preface, 1b
[205] Zhang, *Gao Hu Xi Cao*. Zhang Zuonan preface, 1b

were calibrated to Jinhua and accounted for the differences between Beijing and Jinhua, as well as its local latitude, with updated times based on the present positions of the stars.[206]

To summarize, Zhang advocated for time reform as a type of useful knowledge. These practical exercises borrowed from mathematical tools. They introduced measures of efficiency, and they had various functions that supported local management. In distributing this information, Zhang also sought to connect these local leaders to the kinds of precision management that allowed for them to oversee their local communities. Once they understood the principles of these technologies better, they would be able to support their various constituencies and promote greater trust in the government.

3.4 Conclusions

The challenges of local government management in the early nineteenth century were ripe for ritual precision. Throughout this chapter I have argued that Zhang Zuonan and his circle of friends treated time reform from the perspective of clarifying classical rituals and identifying the proper person. Zhang Zuonan's background in the world of statecraft and history had already prepared him for a unique take on the role of precision in local government and management. Then, as a scholar interested in evidential studies, he became increasingly invested in the field of ritual studies and the clarification of past ritual. Dealing with crises in the first half of the nineteenth century, Zhang Zuonan was an important figure connecting national conversations about statecraft reform to local histories and district level governance.

In terms of "precision", Zhang used astronomical tools to define his concept of precision. Precision was quantitative. It required one to not just be familiar with astronomical concepts, but to be able to apply them to questions of space and local time. To Zhang Zuonan, the tools of the Astronomical Bureau, such as logarithms and sectors, were important devices to practice precision. These tools not only measured phenomena at closer levels, they also created larger sets of data that required manipulation and creative adaptation. In making this material clear, Zhang tried to strike a balance between technical expertise and popular learning. Zhang advocated for the publication and dissemination of this material to new audiences.

This vision of ritual and "public sentiment" made Zhang's practices of precision different from other types of movements dedicated to precision. On the one hand, Zhang Zuonan shared

[206] Zhang, *Jin Hua Gui Lou Zhong Xing Biao*. Zhang Zuonan preface, 1a-2a

several characteristics that have long been established in the history of precision. Zhang was interested in refining celestial measurements, and he especially turned to the worlds of astronomy for where he defined his idea of precision. Zhang also relied on tools and the mechanical use of measurement to transform certain data processes into automatic procedures. This attention to the process of knowledge making connected his thinking to the similar movements present in taking astronomical data and making it more accessible and useable.[207]

Zhang Zuonan, furthermore, shared a wider practice whereby precision justified the expansion and standardization of the state. Quantification was not limited to the physical sciences. The quantifying spirit had also spread to other fields, including forestry, statistics, and demography by the early nineteenth century.[208] Although the common justification for greater precision often came through the demand for uniformity and standardization, many actors justified precision on the grounds that it supported the emerging nation-state.[209] That is to say that the state ended up backing precision. The rise of the quantifying spirit took place within the global competition and the need to target and focus national resources. State demand also structured how Zhang Zuonan treated precision. For him, precision was always about finding a greater sense of efficiency to support the demands of local governments. Precision may have justified local authority, but it ultimately found its significance in maintaining the imperial state.

Nevertheless, the particular vision of precision active in this context differed from other contemporary movements in its explicitly social role. While cultural histories of precision have demonstrated how historical societies have differed regarding their standards of exactitude, the conditions under which a particular value is treated as precision is far more contentious. These studies have shown that tools mattered, but so did particular beliefs about how one defined oneself

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[207] For some of the literature on quantification, measurement, and precision, see "Du Monde de l'«à-Peu-Près» à l'univers de La Précision," in *Études d'histoire de La Pensée Philosophique*, by Alexandre Koyré (Armand Colin, 1961); Thomas S. Kuhn, *The Essential Tension: Selected Studies in Scientific Tradition and Change* (University of Chicago Press, 1977); Ian Hacking, *The Taming of Chance* (Cambridge University Press, 1990); Heilbron, "The Measure of Enlightenment"; M. Norton Wise, ed., *The Values of Precision* (Princeton University Press, 1997); Gluch, "Promises of Precision."; Theodore M. Porter, *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life* (Princeton University Press, 1995).; Mary Terrall, *The Man Who Flattened the Earth: Maupertuis and the Sciences in the Enlightenment* (University of Chicago Press, 2002); William Deringer, *Calculated Values: Finance, Politics, and the Quantitative Age* (Harvard University Press, 2018).

[208] John L. Heilbron, "Introductory Essay," in *The Quantifying Spirit in the 18th Century*, ed. Tore Frangsmyr et al. (University of California Press, 1990), 22-23.

[209] M. Norton Wise, "Introduction," in *The Values of Precision*, ed. M. Norton Wise (Princeton University Press, 1997), 5-9.

and another group.[210] Zhang Zuonan offered another interpretation. Doing precision was often interlinked with the very values it was meant to justify.

Firstly, Zhang suggested that ritual precision was about history and the classics. To understand contemporary solutions, one needed to refine how they applied the classics to state rituals and management practices. This attention to imperial visions of authority could also be framed through Zhang's larger interest in standardization tools. Not all figures wanted to have a strong state, but for many gentry, they agreed on standardization as a component of state responsibility. To ensure homogeneity, however, one had to practice the ritual in the right way.[211] If one factored longitude into the models of local government, then the fundamental role of time could be more appropriately used. This had implications for conducting public rituals and state rituals that were based on orthodox visions of the calendar.

Zhang's theories of precision also had implications beyond the state, because these measures were also used in private rituals and individual contexts. Although religious communities operated under different sets of ritual cycles, in China, religious groups were managed through the state.[212] State standardization through rituals of time created a type of third-party standardization that allowed distinct communities to coordinate and function collectively. Since different community calendars shared some resonance with astronomical phenomena (i.e. solstices, equinoxes, new moon) these elements of calendrical uniformity and what Kevin Birth refers to as planned uncanniness gave strength to the Qing calendar in similar ways as the Gregorian calendar would come to structure life in the twentieth century.[213] Although family life and religious community were shaped by distinct approaches toward social rhythm, astronomical events, like solstices and equinoxes were polysemic. They created shared moments of integration across different calendar traditions and ritual traditions. Therefore, refining the concepts of time and space were fundamental components to creating stable, social order that was at the heart of any statecraft reformer.

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[210] Gluch, "Promises of Precision."

[211] The debates in time have parallels with similar concerns over private and public weights and measures. Sung-Hwa Hong, "Official and Private Weights and Measures (Dulianghengheng 度量衡) during the Qing Dynasty and Contemporary Perceptions," *Sungkyun Journal of East Asian Studies* 20, no. 2 (2020): 185–215.

[212] Vincent Goossaert, "A Question of Control: Licensing Local Ritual Specialists in Jiangnan, 1850-1950," in *Xin Yang, Shi Jian Yu Wen Hua Diao Shi 信仰、實踐與文化調適*, ed. Paul R. Katz and Shu-fen Liu (Zhong yang yan jiu yuan, 2013), 569-604; Tristan G. Brown, "Bureaucracy from the Bottom Up: Diviners in Qing Local Governance," *Journal of Chinese History* 9, no. 2 (2025): 345–78.

[213] Kevin Birth, *Objects of Time: How Things Shape Temporality* (Palgrave Macmillan, 2012), 71-97.

Nevertheless, Zhang Zuonan also treated ritual precision from the perspective of identity and practice. The conditions which enabled actors to create historical reform had themselves changed. With fiscal shortfalls, ecological constraints, and increasing pressure on local and global resources, this period witnessed significant social unrest and calls for a return to order. There were multiple theories for how this type of moral order needed to be practiced. Some scholars, like Fang Dongshu, called for increased attention to Song-learning and the self-cultivation that came from the Cheng-Zhu tradition. Other figures, like Bao Shichen, preferred to work with regulation and argue for alliances between state and merchant so that the state could capture qualities of human nature.

Zhang Zuonan argued that time reform connected state governance with local gentry management. Precision required ritualization. This is to say that only a certain way of doing things allowed for precision to have greater meaning.[214] This attitude toward the "way" of doing was based on certain identities and social hierarchies. Social distinctions were fundamental to this process. Only a certain type of Confucian leader ("true Confucians" versus "vulgar Confucians") could fix this order. Furthermore, similar to the ways in which "Confucian doctors" represented not just technical knowledge but the application of that knowledge through proper moral training in the classics, "Confucian astronomers" and "broad learners" incorporated their technical training within a moral grounding founded upon the classical heritage of ritual practice.[215] The ritualization of practice therefore was not purely about state domination and control. It involved the construction of a new identity that advocated for useful knowledge to benefit the state. At the same time, it generated alliances across bureaucratic lines to promote a type of local gentry activism in technocracy.

Throughout this chapter, I have explored the ways in which state and society came together through the material practices of timekeeping. Zhang Zuonan drew upon the vision of a moral leader to use education to transform his gentry readers into this kind of master of precision. He published and sponsored the creation of public knowledge to make sure that these ideas were no

[214] Catherine Bell, *Ritual Theory, Ritual Practice* (Oxford University Press, 1991), 7-9.
[215] For additional literature on identity and medical practice, see Robert Hymes, "Not Quite Gentlemen? Doctors in Sung and Yuan," *East Asian Science, Technology & Medicine* 8 (1987): 9–76.; Charlotte Furth, "The Physician as Philosopher of the Way: Zhu Zhenheng (1282-1358)," *Harvard Journal of Asiatic Studies* 66, no. 2 (2006): 423–59.; Scheid, *Currents of Tradition in Chinese Medicine*.; Chao, *Medicine and Society in Late Imperial China: A Study of Physicians in Suzhou, 1600-1850*.; Yi-Li Wu, *Reproducing Women: Medicine, Metaphor, and Childbirth in Late Imperial China* (University of California Press, 2010).

longer secret but were instead accessible to broad audiences. Zhang also did not view books as the only means to construct this learning and practice. Zhang treated precision as the product of a set of tools. These tools included artifacts, like tables, sundials, calculators, and mathematical instruments. It also included techniques, algorithms, and procedures. This was a new popular material culture of precision. And it was defined through the circulation of these objects and the training and application of these tools for everyday life in measuring and communicating time.

In the following chapter, I turn to another case study: clocks and their makers. Clockmakers are often associated with precision. But even though Zhang Zuonan and his friends relied on some clocks for their purposes, clockmakers were even more involved in the networks that included astrology and fate calculations. Some Confucian reformers such as Zhang were skeptical about applying astronomical precision toward fate, but clockmakers saw great potential in adapting tools for these purposes.

Chapter 4 Chinese Clockmakers and Selling Time

In 2023, the Kelton Foundation sold a unique Chinese-made clock at auction. The clock had belonged to Richard Kelton (d. 2019), a real estate developer from Los Angeles. Kelton had acquired the clock from a previous owner in Massachusetts, and he had an especial interest in collecting artifacts linked to East Asian and Pacific maritime trade.[1] Clocks in many ways symbolized those connections. Clocks were the first diplomatic gifts that opened China to foreign missionaries in the late Ming. During the height of the Canton trade system, clocks were prestigious gifts to the emperor and for other elites. The Kelton clock (Figure 4-1) told some of that story. Designed in the style of an English bracket clock, it imitated imported clocks from the late eighteenth and early nineteenth centuries. The auction described it as being encased in "English-style rosewood" as well as containing a "British-style" brass movement, even though the Chinese characters found on the clock dispelled the notion that it was an import.[2]

[1] "Lot 580 Suzhou Workshop: China Trade Bracket Clock," China Trade Bracket Clock, Abell Auction, September 24, 2023, https://www.abell.com/auction-lot/suzhou-workshop-china-trade-bracket-clock_00542A78FD. Jeremy Eccles, "The Kelton Collection Heads to Switzerland at News Aboriginal Art Directory. View Information about The Kelton Collection Heads to Switzerland," Aboriginal Art Directory, December 3, 2020, https://news.aboriginalartdirectory.com/2020/12/the-kelton-collection-heads-to-switzerland.php. "China Trade Paintings: Selections from the Kelton Collection," Christie's, November 7, 2019, https://www.christies.com/en/auction/china-trade-paintings-selections-from-the-kelton-collection-28601/overview.

[2] Clare Vincent et al., eds., *European Clocks and Watches in The Metropolitan Museum of Art* (Metropolitan Museum of Art, 2015).150-153; Andrew Nicholls, *English Bracket and Mantel Clocks* (Blandford Press, 1981). 7-8, Richard Barder, *The Georgian Bracket Clock, 1714-1830* (Antique Collectors' Club, 1993).



Figure 4-1: Chinese Bracket Clock. This bracket clock was sold in 2023. It is made up of a wooden case with a mother-of-pearl inlay, and a green painted enamel dial. Above the circular dial plate, there is a smaller decorative circle which contains traditional Chinese motifs. Source: Abell Auction House. September 24, 2023. Lot 580.

Despite sharing a general form with English-style models, upon closer inspection, this clock is remarkable for what it reveals about Chinese clockmakers and their practices. First, clockmakers were not simply copying. They modified designs like modules. Take, for instance, the rosewood case and enamel dial. The wooden case employed common decorative techniques from Chinese furniture design, such as mother-of-pearl inlay. Mother-of-pearl inlay had a complex history. Eighteenth-century chinoiserie included mother-of-pearl inlay as one of the techniques associated with its decoration.[3] But it had precedents in Ming and Qing furniture.[4] Shell inlays, when combined with swirls, created a floral effect to accent the wood.[5] Furniture makers used these techniques to design framing structures for table screens and other artifacts appreciated in

[3] William Chambers, *Designs of Chinese Buildings, Furniture, Dresses, Machines, and Utensils* (Published for the Author, 1757). 11-12. For additional context on mother-of-pearl as a medium, see Daniëlle Kisluk-Grosheide, "Dirck van Rijswijck (1596-1679), a Master of Mother-of-Pearl," *Oud Holland* 111, no. 2 (1997): 77–94.; Beate Fricke, "Matter and Meaning of Mother-of-Pearl: The Origins of Allegory in the Spheres of Things," *Gesta* 51, no. 1 (2012): 35–53.; Anna Grasskamp, *Art and Ocean Objects of Early Modern Eurasia: Shells, Bodies, and Materiality* (Amsterdam University Press, 2021).

[4] Jonathan Hay, *Sensuous Surfaces: The Decorative Object in Early Modern China* (Reaktion Books, 2010). 177-179

[5] This technique was particularly associated with clocks from Guangzhou. Nanjing bo wu yuan, *Jing Zhun Yu Hua Mei: Nanjing Bo Wu Yuan Cang Zhong Biao Jing Pin 精準與華美: 南京博物院藏鐘錶精品* (Feng huang chu ban she, 2013). 88-91

literati culture. By playing with the function of clocks and table screens, Chinese furniture designers drew upon their own traditions for framing objects to showcase clockwork in an outer wooden structure. Enamel dials similarly transformed the object into local motifs. Most English bracket clocks contained a function for silencing the bells. The silencer, which was a part of the mechanism and therefore a circular piece of metal, was typically placed above the white enamel dial.[6] However, in place of this, the designer painted a circle and used auspicious motifs from Chinese art. The new painted circle contained a bowl with fruits and flowers, like the peony and pomegranate, as symbols of good fortune. These positive symbols can be found on other parts of the clock exterior as well. Chinese clockmakers modified parts of the clock as a system to adjust components for local visual and material culture.

Secondly, besides design, what is perhaps even more surprising is that hidden behind the dial the clockmaker left traces of his practice on the clock. He made inscriptions as a part of his making or repair. The inscriptions (Figure 4-2) included numbers and references, not all of which are decipherable to us today. What is clear is that the maker added notes for the day that he was working. He wrote the year and month at the top of the dial's backside which dates this clock to the first lunar month of the "thirty-fourth" year, most likely 1908 from the late Guangxu reign (1875-1908). In addition, rather than using common characters to represent these numbers, he employed Suzhou numerals (e.g. 卅乂年正月). These numbers were written in left-right format. They were descendants of rod-based mathematics and were used in the late imperial period to copy the position of beads on an abacus plate. Sometimes referred to as "commercial" numbers, they followed tally-mark rules. For that reason, they were easy to use and played an important role throughout everyday life and commercial transactions.[7] The marks left on the back lead us to conclude that this maker was not only literate, but that writing had a place in his workshop and repair practice.[8]

[6] Nicholls, *English Bracket and Mantel Clocks*. 52-54

[7] Lionel Charles Hopkins, "The Chinese Numerals and Their Notational Systems," *Journal of the Royal Asiatic Society of Great Britain and Ireland*, 1916, 315–33. Lionel Charles Hopkins, "The Chinese Numerals and Their Notational Systems. Part II," *Journal of the Royal Asiatic Society of Great Britain and Ireland*, 1916, 737–71.

[8] There is a pocket watch that records a similar practice, repaired by Wang Yu 王玉 in 23.6.5. William Ilbery, *Ilbery Gold and Enamel Chinese Market Pocket Watch*, c 1810, Gold, 59 mm, Macau Time Museum, PW1905010.



Figure 4-2: Back View of Chinese Bracket Clock. The back side is covered in several Chinese characters. The year date is listed at the top center of the plate, and the month reference followed by other less decipherable notes continues down the middle of the plate. Source: Back View, Abell Auction House. September 24, 2023. Lot 580

The materiality of objects like this clock reminds us that physical artifacts preserve and archive historical practices. Consequently, this chapter shows that looking at clockmakers as a specialized community of artisans reveals the creative adaptation of time. Using manuals, oral histories, private documents, and physical clocks, this chapter explores how clockmakers practiced their trade and became cultural liaisons to explain mechanical time. Chinese clocks and clockwork technology performed double duty as both popular forms of entertainment that signaled wealth and status as well as indicators for new ways of interpreting, communicating, and representing time. Clockmakers capitalized on the relaxation in the market for time to create entertaining devices that both stimulated the senses and educated audiences about astronomy, measurement, and useful knowledge.

With these material practices, clocks like the Kelton clock encourage us to look at individual modifications as an iterative form of innovation to explore how clockmakers viewed their clocks themselves and how these makers tried to imagine and produce new tools for their audiences. Earlier scholarship has focused especially on the questions of technology and culture.[9]

[9] Carlo M. Cipolla, *Clocks and Culture, 1300-1700* (W. W. Norton & Company, 1978); Joseph Needham et al., *Heavenly Clockwork: The Great Astronomical Clocks of Medieval China*, Second Edition (Cambridge University Press, 1986); David S. Landes, *Revolution in Time: Clocks and the Making of the Modern World*, 2nd ed. (Belknap Press, 2000).

For Carlo Cipolla, traditional society and values in imperial China limited the need for clocks compared with Japan. Japanese clockmakers modified dial faces and escapements to report hours. The Tokugawa period also witnessed a new commercialization of society that introduced incentives for change. In contrast, Cipolla claimed Chinese clocks remained small-scale enterprises and illustrated little significant innovation in design or shape. "It failed to produce anything original," he wrote.[10]

With the opening of imperial archives, scholars have challenged aspects of this thesis, especially in terms of the eighteenth century and the imperial workshops. Catherine Pagani, Li Youru, and Guo Fuxiang have all shown how local cultures of making impacted the design of clocks in China.[11] Yet even though these historians have recovered cultural exchanges and revised narratives about clocks in China, they have tended to resolve questions of time modernization by focusing on art historical exchanges or luxury consumption. Hence, Pagani draws the following conclusion: "While [clocks] could be used to announce the time, the principal value of these clocks and watches lay in their external appearance and symbolic meanings; as timepieces, they were of little practical use in regulating the day…The true function of these objects was as signifiers of social standing for their officials and wealthy elite."[12] This argument recognizes the impact of clocks, but it distinguishes between the *social functions* of clocks as material representations of status with clocks as *cognitive devices* for knowing time. In this framework, the technical infrastructure that changed social values of time occurred under later conditions through state-sponsored industrialization, global integration in the treaty ports, and new attitudes towards science and technology, which had their greatest impact during the long Republic.[13]

Having established that a market for time already existed by the Qianlong and Jiaqing reigns, I argue that design and technology did not just impact status but also instrumentation

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[10] Carlo M. Cipolla, *Clocks and Culture, 1300-1700* (W. W. Norton & Company, 1978), 97

[11] Catherine Pagani, *"Eastern Magnificence & European Ingenuity": Clocks of Late Imperial China* (University of Michigan Press, 2001); Li Youru, *Zhong biao, zhong lou yu biao zhun shi jian: xi shi ji shi yi qi ji qi yu Zhongguo she hui de hu dong (1582-1949) 鐘錶, 鐘樓與標準時間: 西式計時儀器及其與中國社會的互動 (1582-1949)* (Zhengzhi daxue lishi xi 政治大學歷史系, 2012); Guo Fuxiang, *Shi Jian de Li Shi Ying Xiang: Zhongguo Zhong Biao Shi Lun Ji 時間的歷史映像: 中國鐘錶論集* (Gu gong cheng chu ban she, 2013).

[12] Pagani, *Eastern Magnificence & European Ingenuity*. 96

[13] Wang Erh-min, *Ming Qing Shi Dai Shu Min Wen Hua Sheng Huo 明清時代庶民文化生活* (Yuelu shu she, 2002), 25-33.; Qin Shao, *Culturing Modernity: The Nantong Model, 1890-1930* (Stanford University Press, 2004), 86-101; Wen-hsin Yeh, *Shanghai Splendor: Economic Sentiments and the Making of Modern China, 1843-1949* (University of California Press, 2007), 79-100. For the place of scientism in Republican-era political culture, see D. W. Y. Kwok, *Scientism in Chinese Thought, 1900-1950* (Yale University Press, 1965); Sean Hsiang-lin Lei, *Neither Donkey nor Horse: Medicine in the Struggle over China's Modernity* (University of Chicago Press, 2014).

because clockmakers built their clocks for distinct audiences and for multiple purposes. In the same vein as Yulia Frumer, I suggest that the material culture of timekeeping also shaped Chinese clockmakers under certain conditions. The Chinese case differed from Japan because Chinese clockmakers always remained embedded, albeit on the margins, within the global clock and watch economy. Chinese clockmakers had to engage much more with the expectations of design predicated on alterity in contrast to Japanese clockmakers where mechanics deconstructed and rebuilt clocks through what Frumer via Davis Baird dubs the material characteristics of the devices themselves.[14] Despite this difference, both Chinese and Japanese clockmakers engaged with existing material cultures for measuring time as models for teaching and communicating it. Furthermore, while Chinese clockmakers initially had close relationships with the imperial workshops, with the rise in the market for time, they started to transmit their skills in the market supporting a distinct set of practices that allowed them to sell their expertise and promote mechanical models of time as useful knowledge.

This chapter therefore focuses on two main aspects of Chinese clockmaking. In section I, I document who mattered in the community of Chinese clockmakers and how these artisans changed over time. I argue that Chinese clockmakers used modular assembly to create heterogenous approaches towards clocks, and that clockmakers cultivated a particular identity as clock and watch repairers. I describe four distinct communities of clockmakers in Beijing, Guangzhou, Nanjing, and in other sites as groups that formed specific communities centered on knowing clockwork and supporting the popularization of clocks and watches. In section two, I focus on two types of clocks to illustrate how clockmakers advocated for applying mechanical time for Chinese problems in time measurement. Using the cases of night clocks and astronomical clocks, I argue that once clocks fit into the local ecology or timescape, clockmakers sold these devices under the market for time. Similar to almanac makers, Chinese clockmakers made clocks that supported popular education and which allowed individuals to use devices to make time meaningful for themselves. Clocks did not automatically require a particular attitude about time. But neither were clocks solely artifacts of social status. For clockmakers, clocks had useful

[14] Yulia Frumer, *Making Time: Astronomical Time Measurement in Tokugawa Japan* (University of Chicago Press, 2017). 13. For Baird's argument on the material knowledge of instruments, see Davis Baird, *Thing Knowledge: A Philosophy of Scientific Instruments* (University of California Press, 2004).

functions that could be captured when mechanical devices were designed for enhancing those specific features.

4.1 Chinese Clockmakers

Defining Chinese Clockmakers

Who was a Chinese clockmaker? What distinguished this profession in China compared to other places in the world? What was clockmaking called as a craft in China and what kind of skills did it cultivate? These questions are important to address here because clockmaking involved a wide range of practices. It might include mechanical knowledge, design, engraving, and more. The stages going from raw material to finished product often involved many different crafts and skills.

These practical concerns had already led to differences in the European and American contexts by the early nineteenth century. For instance, early clockmakers relied on suppliers to produce rough versions of the metal components, before they started refining the pieces for the clock products. By the late eighteenth century, clockmakers, especially in comparison with watchmakers, relied on prefabricated parts. Clockmakers also did not typically make the wooden cases or the enamel dials, but they instead subcontracted this work out to specialists in those crafts. Although watchmaking and clockmaking were related industries, the two groups organized their crafts into distinct trades with their own traditions of apprenticeship and training. These categories might overlap with other types of hierarchies in prestige. For instance, there were additional distinctions between specialty precision markets, like chronometers, astronomical timekeepers, and mathematical instruments, compared to the lower end of the market which prioritized maintenance of community and domestic clocks. These matters of organization and control in training and skill were important components to the process in forming a trade and professional form of organization around clocks and watches.[15]

I define Chinese clockmakers in the broadest possible terms. Firstly, Chinese clockmakers did not start to specialize with clocks versus watches until the end of the nineteenth and the

[15] For more detail on these changes in organization and the role of guilds and trade, see Joyce Brown, "Guild Organisation and the Instrument-Making Trade, 1550–1830: The Grocers' and Clockmakers' Companies," *Annals of Science* 36, no. 1 (1979): 1–34. Maurice Daumas, *Scientific Instruments of the Seventeenth and Eighteenth Centuries and Their Makers* (Praeger Publishers, 1972). Alun C. Davies, *The Rise and Decline of England's Watchmaking Industry, 1550-1930* (Routledge, 2022). Paola Bertucci, *Artisanal Enlightenment: Science and the Mechanical Arts in Old Regime France* (Yale University Press, 2017).

beginning of the twentieth centuries, but clockmakers did have a shared identity through knowing how to use clockwork mechanisms. This meant that the types of artifacts involved in clockmaking were more about the connection to devices based on gears and springs. This could even include automata and self-winding toys.

Chinese clockmakers can be defined according to two distinctive workshop practices. The first was their modular approach toward reconstructing and assembling clocks either by copying earlier parts or disassembling and building new cases to construct localized products. Secondly, building on this modularity and organizational approach toward raw materials, clockmakers translated their skills into a variety of different repair contexts. Repair was probably the most significant feature around how clockmakers organized their work, some even using their skills to become itinerant workers much like other fixing trades.

Modular Approach to Clocks

If one practice could be used to describe the making of Chinese clocks, it would have to be their "modularity" or heterogenous assembly. I use modular in part because this term has been influential in analyzing Chinese models of production and craftsmanship.[16] Whether in ceramics, architecture, and bronze casting, Chinese artisans engaged in what Lother Ledderose has called a "modular system of production." In Ledderose's definition, modularity referred to a system of making that came through standardizing sets of modules. By combining modules, artists developed creativity and variety. Modular systems on the surface appeared standardized but upon inspection resulted in individual differences as new combinations created unique variations.[17] Chinese clockmakers shared elements of this practice. They worked with multiple components, and they mixed these elements together. Similarly, clockmakers used prefabricated materials that they recombined to build variations. They also copied to reproduce designs with slight adjustments. Nevertheless, modularity for Chinese clockmakers was not the same as Ledderose's modularity. For Ledderose, modularity demonstrated a preindustrial form of factory organization, because it centered on mass production. But clockmaking workshops were not factories. In fact, even as

[16] Lothar Ledderose, *Ten Thousand Things: Module and Mass Production in Chinese Art* (Princeton University Press, 2000).; Anthony J. Barbieri-Low, *Artisans in Early Imperial China* (University of Washington Press, 2007).
[17] Ledderose, *Ten Thousand Things*. 1, 2-4, 16-18

clockmaking and watchmaking developed greater divisions of labor in European contexts, Chinese workshops remained mostly family run with a small number of apprentices.

Modularity as I define it in the world of clockmaking relies more on the heterogeneity of assembling. This was a practice that focused on components and parts. Modularity reflects the approach toward finding immediate solutions with ready-made parts or what is at hand. This type of combination is perhaps more consistent with the idea of the bricoleur. That is to say that materials are based on their contingent nature and the "devious" methods of finding solutions.[18]

This sense of bricolage or the coming together of different parts also reflects how clockmakers repurposed and used materials to fit into their various projects. Although some scholars have emphasized the category of "recycling" to refer to aspects of this approach, recycling implies supply blockage or value toward sustainability so that one reuses the materials in order to deal with scarcity in a new way.[19] Chinese clockmaking by contrast was not usually one of scarcity. In fact, resources and materials were accessible, and the sites for clockmaking overlapped with important logistical hubs. I emphasize "modular" to highlight that Chinese clockmakers distributed their approach both toward the material itself and toward the organization of different components. They shared similarities with European clockmakers and watchmakers in this view toward sub-contracting, but the Chinese workshops were less structured in their approach towards these assembly processes.

Modularity, furthermore, captures the inherent hierarchies between makers and their skills or materials, as in a "tinkerer" or "handyman" versus "artisan" and "craftsman."[20] This

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[18] Levi-Strauss, *The Savage Mind*. 16-18; Christopher Johnson, "Bricoleur and Bricolage: From Metaphor to Universal Concept," *Paragraph* 35, no. 3 (2012): 355–72. Charlotte Furth has also described such eclecticism in the formation of medical texts as another form of bricolage. Charlotte Furth, *A Flourishing Yin: Gender in China's Medical History, 960–1665* (University of California Press, 1999). xxxii. I thank Yi-Li Wu for drawing my attention to this broader context.

[19] Frank Dikötter, *Things Modern: Material Culture and Everyday Life in China* (Hurst and Company, 2007).61-64; Stefan Krebs and Heike Weber, eds., *The Persistence of Technology: Histories of Repair, Reuse and Disposal* (Transcript Verlag, 2021).

[20] These terms carry value distinctions in terms of quality and skill. Recently, the idea of "tinkering" has captured the idea of creative innovation through modification. This practice has a particular element of copying and engagement that might also be a way to understand Chinese clockmaking. For comparison, see Eugenia Lean, *Vernacular Industrialism in China: Local Innovation and Translated Technologies in the Making of a Cosmetics Empire, 1900-1940* (Columbia University Press, 2020). 8-11; Honghong Tinn, *Island Tinkerers: Innovation and Transformation in the Making of Taiwan's Computing Industry* (MIT Press, 2025). For additional context on tinkering, see Kathleen Franz, *Tinkering: Consumers Reinvent the Early Automobile* (University of Pennsylvania Press, 2005).; Mary Burke, *"Tinkers": Synge and the Cultural History of the Irish Traveller* (Oxford University Press, 2009).; Hugo Gernsback, *The Perversity of Things: Hugo Gernsback on Media, Tinkering, and Scientifiction* (University of Minnesota Press, 2016).

heterogeneity was an aspect which impacted perceptions of Chinese clockmakers vis-à-vis European clockmakers. Early visitors to China commented on the fact that local artisans were talented, but they relied especially on imitating parts and constructing through several sets of supplies. George Anson, for example, stopped at Canton in the mid-18th century. He was one of the first reporters to comment on the rise of Chinese clockmakers. He praised local artisans for their creativity, but he also argued that in the case of mechanical accuracy, as required in building clocks, watches, and firearms, Chinese makers were on the whole of a lower quality compared to European crafts. He wrote, "Though they can copy the different parts, and can form some resemblance of the whole, yet they never could arrive at such a justness in their fabric, as was necessary to produce the desired effect."[21] Some years later, in 1793 to 1794, John Barrow wrote that it was now common knowledge that Chinese clockmakers could largely reproduce English watches and produce a variety of clocks, if one provided a mainspring.[22] In the 1830s to 1840s, global traders also reiterated that while the local trade competed with and changed the supply networks, clockmakers throughout China still relied on import networks for several internal parts which challenged the making process.[23] Several other observers to the trade also added that local makers relied on global supply networks of parts.[24]

Archival records from the Imperial Workshops shed additional light on this eclectic approach toward heterogeneous assembly. For instance, in Qianlong 37 (1772), the Clock-making Workshops received a work order for several new clocks. They had to send multiple requests to other departments to collect the materials. Work orders went to the enamel workshop for producing dials, and they sent plans to the metal workshop for building mainsprings, a component called the *fatiao* 法條 of the clock. The metal workshop, however, was unable to fill the order for unstated reasons. So, the Imperial Household sent a supply request to administrators in Guandong for

[21] Richard Walter et al., *A Voyage Round the World, in the Years MDCCXL, I, II, III, IV* (Printed John and Paul Knapton, 1748), 411-412

[22] John Barrow, *Travels in China, Containing Descriptions, Observations, and Comparisons, Made and Collected in the Course of a Short Residence at the Imperial Palace of Yuen-Min-Yuen, and on a Subsequent Journey through the Country from Pekin to Canton* (T. Cadell and W. Davies, 1804).306-307.

[23] John Robert Morrison, *A Chinese Commercial Guide, Consisting of a Collection of Details Respecting Foreign Trade in China*, 1st Edition (Printed at the Albion Press, 1834). 111

[24] Pierre Dobel, *Sept Années En Chine: Nouvelles Observations Sur Cet Empire : L'archipel Indo-Chinois, Les Philippines et Les Îles Sandwich*, trans. Emmanuel Galitzin (Amyot, 1842). 176, 318; Unfortunately, the English edition of this work removed the notes. Peter Dobell, *Travels in Kamtchatka and Siberia: With a Narrative of a Residence in China*, 2 vols. (Henry Colburn and Richard Bentley, 1830). Daniel Jerome Macgowan, "On Chinese Horology, with Suggestions on the Form of Clocks Adapted to the Chinese Market," in *Report of the Commissioner of Patents for the Year 1851 Part I* (U.S. Government Printing Office, 1852).336

mainsprings of different lengths and sizes. These orders were fulfilled through local purchases with Western merchants. The springs were shipped to Beijing where they were used by the workshops to construct the required clocks.[25]

Archival records state that workshops disassembled old clocks and reused the components for other clocks. Such a documented example occurred in late 1790. The Clock-making workshop received a new order from the Imperial Household to build a table clock. The order stated that the manufacturing office should use a self-ringing clock *zimingzhong* 自鳴鐘 as the base for the new clock. They compiled a list of supplied pieces, and the managers recorded that the office took the mechanisms from a musical clock and exchanged them into a new frame. The collected *zitan* wood to produce the new frame. This then became the basis for the new table clock.[26]

Work records and supply lists like this indicate that imperial clockmakers used multiple strategies for creating their clocks. They sometimes built their pieces from scratch, but they also relied on gathering materials from different sources. They could even recycle materials from older clocks to build new types of clocks.

In addition to documentary evidence, extant clocks provide another source for analyzing these practices of reuse and mixing. For instance, there is a second clock sold from the Kelton collection that includes such modular building. The exterior case is made from porcelain. The case is covered with scenes from Chinese popular culture, including auspicious motifs in patterns on the sides as well as court scenes drawn from vernacular and popular literature. The front cover includes a classical reference (*ri yue zhe yi* 日月逝矣 "the days and months pass by"), and so the case was most likely made in China, not a clock produced for export by European designers. But the interior mechanism contains the label from the U.S. manufacturer, having been removed from another clock and added to this one.[27]

Similar examples exist for clocks with provenances attached to makers in Guangzhou and in Beijing.[28] For instance, one clock (see Figure 4-3) that dates to the Qianlong period is an

[25] Zhongguo di 1 li shi dang an guan, *Qing Gong Nei Wu Fu Zao Ban Chu Dang an Zong Hui* *清宮內務府造辦處檔案總匯*, Di 1 ban. (Ren min chu ban she, 2005). Vol 35, 445
[26] Zhongguo di 1 li shi dang an guan, *Qing Gong Nei Wu Fu Zao Ban Chu Dang an Zong Hui*. Vol 52, 39
[27] "Lot 421: Chinese Export Porcelain Shelf Clock," Abell Auction, September 25, 2022, https://www.abell.com/auction-lot/chinese-export-porcelain-shelf-clock_D534467B2F.
[28] Roger Smith, "The Sing-Song Trade; Exporting Clocks to China in the Eighteenth Century," *Antiquarian Horology* 30, no. 5 (2008): 629–59.645; Silvio E. Bedini, "Chinese Mechanical Clocks," *Bulletin of the National Association of Watch and Clock Collectors* 7 (1956): 219-220.

automaton clock that simulates the movement of flowers. The clock base is a flower vase and has a white enamel dial that resembles a traditional floral arrangement. Although the exterior is a Chinese design, the internal mechanism is not. It is of French origin.[29] In another case, a cabinet (see Figure 4-4) designed in Guangzhou also mixes materials. The item was a tribute item from Guangzhou. The main front piece is made from painted glass and contains several small objects as a part of the court fashion in small hidden compartments. On the top of the container, there is a timepiece, which has been incorporated into the frame. The labels on the watch reveal that the piece was made by a London-based watchmaker, George Beefield (fl. 1760), and were then attached and incorporated into the design primarily through the structure of the cabinet.[30]



Figure 4-3: Palace Museum Flower-Pot Clock. This clock, manufactured in Guangzhou, combined a floral arrangement with a watch. The watch announces the time, and the flowerpot also contains a mechanism that moves the flowers. Source: Beijing Palace Museum, Qianlong period. 154 cm x 68 cm.

How should we evaluate this approach? On the one hand, the mixed nature of these products is part of the reason why critics have disparaged Chinese clocks. The clocks have been described as derivative or imitative. In some cases, scholars have argued that the makers were

[29] Gu gong bo wu yuan (China), *Qing Gong Xi Yang Yi Qi 清宫西洋儀器*, Di 1 ban., ed. Lu Liu, Gu Gong Bo Wu Yuan Cang Wen Wu Zhen Pin Quan Ji = Complete Collection of Treasures of the Palace Museum ; 58 (Shang wu yin shu guan (Xianggang) gu fen you xian gong si, 1998). 234, fig. 208
[30] Gu gong bo wu yuan (China), *Qing Gong Xi Yang Yi Qi* .242, fig. 216

more interested in creating different types of cases than they were in gaining better skills in designing movements and the internal mechanisms. Technical restrictions might also have played a factor in this arrangement. For instance, according to one report, while the Dutch assembled some clocks in Batavia, local artisans were unable to produce mainsprings because of the local climate conditions. This was claimed to be environmental, not because of a skill gap.[31] At the same time, Chinese artisans were capable of detail work, but they relied on training and dexterity with knives or cutting tools more than machine-based methods. A machine tool like the lathe existed in China. And there is evidence to suggest that the Jesuits used these machines in the imperial workshops. But these lathes were generally limited to only a few specific contexts with jewelry and ivory-working.[32]

[31] Charles Frederick Noble, *A Voyage to the East Indies in 1747 and 1748: Containing an Account of the Islands of St. Helena and Java ; of the City of Batavia ; of the Government and Political Conduct of the Dutch ; of the Empire of China, with a Particular Description of Canton, and of the Religious Ceremonies, Manners and Customs of the Inhabitants : Interspersed with Many Useful and Curious Observations and Anecdotes, and Illustrated with Copper-Plates*, with Thomas Durham (Printed for T. Becket and P.A. Dehondt at Tully's Head : and T. Durham at the Golden Ball near Norfolk-Street in the Strand, 1762). 87

[32] Ching-fei Shih, "Unknown Transcultural Objects: Turned Ivory Works by the European Rose Engine Lathe in the Eighteenth-Century Qing Court," in *EurAsian Matters: China, Europe, and the Transcultural Object, 1600-1800*, ed. Anna Grasskamp and Monica Juneja (Springer, 2018). 57-76; Joyce Yusi Zhou, "European Turned Ivories at the Chinese Imperial Court: A Study in Early Modern Cross-Cultural Knowledge Transmission (1617-1735)," *Essays in History* 54, no. 1 (2020): 1–22. Bing Huang, "From God's Hand to the Hand of the Artisan: The Turned Ivory Sphere and the Polyhedron in Qing China," *Studies in Chinese Religions* 8, no. 2 (2022): 202–37.



Figure 4-4: Treasure Cabinet with Watch. This object is also called a *duobaoge* 多寶閣 "cabinet for many treasures" clock.[33] The user can open the front cabinet to reveal multiple compartments for storing other artifacts. The furniture item was a type of specialty display case that became popular at the court. The decoration that surrounds the cabinet contains a watch, similar to a mirror or other multiple purpose item for domestic and private furniture. Source: Qianlong period. 66 cm x 30 cm. Beijing Palace Museum, Gu 00183442.

Modularity provides a useful analytic for thinking about these clocks because it recognizes that makers were selective about their approach. Some of these decisions had unexpected consequences integrating clockmaking workshops into the broader process of standardizing internal parts and components. Similar to the ways in which managers of clock workshops in a European context were collaborating with multiple processes that were assembled centrally, Chinese workshops also cultivated logistical awareness. This prioritized both an awareness about internal materials and an outward attitude toward global networks, because Chinese clockmakers were always cognizant of the fact that their craft was indebted to imported skills.

First, modularity shaped the practice of copying. Chinese clockmakers did not just imitate movements and structure wholesale, but rather they treated European imports as models by which they could construct and adjust components for different uses, sometimes relying on it to solve the problem and other times using the model as a standard for producing copies. Several mechanisms can be identified as Chinese products, because the designs copied the structure of English-bracket clocks. Other features give away that the movement was a local product rather than an import.

[33] Nicole T. C. Chiang, *Emperor Qianlong's Hidden Treasures: Reconsidering the Collection of the Qing Imperial Household* (Hong Kong University Press, 2020).73-74, 76-77

There is an English-style mantle clock (see Figure 4-5) in the museum of the National Association of Watch and Clock collectors. The clock appears to be an English-clock in almost all features, but several of the written letters are nonsense. The description for the clock claims that it was made in England but designed for the Chinese market, which is why the letters were inaccurate. Considering how uncommon it is to see bracket clocks made in England with such inaccuracies, I would suggest, however, that it is more likely that this clock is an example of a Chinese-made product that has copied the English style.

Although a closer material analysis of this clock's metal and wood might clarify the issue better, there are plenty of other examples with a more certain provenance and analysis that highlight the fact that copying was a major part of local practice in clockmaking. For instance, one of the clocks included in the Palace Museum collections was a product of the tribute from Guangzhou. The clock is an English-style bracket clock, but the back includes Chinese ornamentation in the same style as the English model with Canton added on the back.[34] Silvio Bedini, one of the leading clock historians, identified several other clocks in this manner. These clocks sometimes directly copied the movement and labeled it as if it were from London. In other cases, the clockmakers sometimes used inaccurate writing to represent an English model.[35]

[34] Guangdong sheng bo wu guan, *Guangdong Sheng Bo Wu Guan Cang Pin Xuan 廣東省博物館藏品選* (Wen wu chu ban she, 1999), Guangdong Sheng bo wu guan cang pin xuan. 287, fig. 48

[35] Silvio E. Bedini, "Oriental Concepts of the Measure of Time," in *The Study of Time II: Proceedings of the Second Conference of the International Society for the Study of Time Lake Yamanaka-Japan*, ed. James T. Fraser and Nathaniel Lawrence (Spring, 1975). 456, 461, 464; Bedini, "Chinese Mechanical Clocks."220



Figure 4-5: Bracket Clock with Faux English. This item is an English-style bracket clock. The origin of the clock is listed as China, but there is a question whether the artifact was manufactured in China or first produced in England and then sold in China. Above the white enamel dial, there is a silencer. But the letters are all misspelled. I argue that this artifact was probably made locally through imitation. Source: Author Image, National Watch and Clock Museum. Ca. 1800. 2000.21.85.

Copying was an essential practice in the world of elite craftsmanship, because it created consistency and standardization across distance through reproducing experience and knowledge apart from textual knowledge. This was a specific approach toward learning that has been called "vernacular" and "artisanal epistemology." "Artisanal epistemology" refers to the situated knowledge that comes through the engagement with raw materials and the manipulation of their effects through trials and experiments. As Pamela Smith notes, one of the central modes to build this specialized workshop knowledge came through imitation, repetition, and training with models.[36] Such repetition with a model was one way that artisans in China evaluated each other. For instance, in the Qing workshops, three-dimensional models were used as tests for jade artisans and architects. The final examination to determine that an artisan qualified as a skilled artisan in their craft was the artisan's ability to replicate a model that they were given.[37] This form of

[36] Pamela H. Smith, *The Body of the Artisan: Art and Experience in the Scientific Revolution* (University of Chicago Press, 2004).19; For additional work on the relationship between text and material experience, see Smith, *From Lived Experience to the Written Word*.

[37] Dagmar Schäfer, "Knowledge by Design - Architecture and Jade Models during the Qianlong Reign (1735-1796)," in *The Structures of Practical Knowledge*, ed. Matteo Valleriani (Springer, 2017). 273-274, 276-277, 282-284

examination had practical consequences when dealing with long-distance communication. Because managers were not always able to communicate demands or expectations to a craftsman, three-dimensional models could be transported to new sites. When artisans worked with the model, they could then start to replicate and create new objects in line with the standard design. Physical models served as a type of standardization tool by which distant communities could create elements of uniformity even when they had to rely on local supplies to recreate the physical model.[38]

Clockmakers shared similar workshop practices. For instance, imitation and material expertise were at the heart of the training. Our knowledge about this comes through oral histories from various clockmakers. Xu Wenlin 徐文璘 trained in clock repairs at the end of the dynasty, and he transmitted his teaching to four disciples: Ma Yuliang 馬玉良, Bai Jindong 白金棟, Chen Heran 陳賀然, and his son Xu Fangzhou 徐芳洲.[39] In an interview with Ma Yuliang about his practice, Ma claimed that Xu taught his apprentices to work by hand and memory. Ma was not allowed to use drawings of the internal parts or write down the instructions during the learning process. He was supposed to commit all the work to memory which came by watching and slowly practicing with the internal gears, followed by additional work using machine tools like lathes for building replaceable parts.[40]

This workshop ideal, which prioritized the close engagement with a physical object and its internal components, encouraged Chinese clockmakers to match their making with other types of globalizations in measurement standards. For instance, one of the most fragile and careful components that the clockmakers cared about during the assembly process was screws.[41] For a variety of reasons, screws were less common in Chinese technical culture, and the technology for threading remained still sporadic even by the mid-20th century. [42] Nevertheless, where screws were

[38] For additional context on the bureaucratic role of models as a communication media, see Kaijun Chen, *Porcelain for the Emperor: Manufacture and Technocracy in Qing China* (University of Washington Press, 2023). Daniel Asen, "Dead Bodies and Forensic Science: Cultures of Expertise in China, 1800-1949" (Phd Dissertation, Columbia University, 2012). 36-71; Hyeok Hweon Kang, "Crafting Knowledge: Artisan, Officer, and the Culture of Making in Choson Korea, 1392-1910" (Phd Dissertation, Harvard University, 2020).
[39] Qin Shiming, "Qing Gong Zuo Zhong Chu de Yan Xu - Beijing Gu Gong Bo Wu Yuan Gu Zhong Biao Zhi Xiu Fu 清宮做鐘處的延續 - 北京故宮博物院古鐘錶之修復," *Gu Gong Wen Wu Yue Kan*, no. 317 (2009): 12–19.
[40] Allen H. Weaving, "Clocks for the Emperor," *Antiquarian Horology* 19, no. 4 (1991): 384.
[41] Weaving, "Clocks for the Emperor."384; Qin, "Qinggong Zuozhongchu de Yanxu."14-16
[42] Joseph Needham and Wang Ling, *Science and Civilisation in China*, Volume 4: Physics and Physical Technology, Part II: Mechanical Engineering (Cambridge University Press, 1965).119-122; Randall C. Brooks, "Origins, Usage

employed were primarily trades and objects tied to foreign exchanges, such as turned ivory spheres, silver candlesticks, and clocks. In a rarely-cited but detailed study on Chinese metalwork in the export trade, the author analyzed several sets of Chinese-made screws. This set of data included screws used in Chinese-made clocks. The results of the analysis were particularly insightful for understanding processes of globalization in standardizing tools across borders. On the one hand, the screws in China were not uniformly made. Some were produced by machine, including ones that allowed for more uniform distance in the thread. Others were instead produced by traditional casting methods. The significance though is that the screws were generally uniform and were based on several of the competing standards that were circulating in England in the early 19th century and which belonged to the standardization debates about how to create shared measurements for producing replaceable parts. The distances used in the screws are generally in agreement with the standards that were in place before the Whitworth standardization reforms starting around 1850 to 1860.[43]

While Chinese makers were not involved in this dialogue, they were still making products that imitated this tradition by adapting physical models that were circulating through trading centers. In some cases, such as with export silver, Chinese artisans were producing artifacts that were meant to copy English models, yet which relied on much cheaper materials and traditional methods. They copied industrial standards through the imitation of the original model.[44] In other cases, such models like screws were being reproduced within Chinese workshops to connect the heterogenous parts which were both manufactured locally and the materials that were imported. Consequently, even as clockmakers started to produce their own versions of these clocks, the movement of physical materials from one location to another created connections that were based on shared goals of connecting different parts even though the techniques and methods used to manufacture and produce the internal components were not identical.

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and Production of Screws: An Historical Perspective," *History and Technology: An International Journal* 8, no. 1 (1991): 51–76.

[43] Eldon Edward Worrall, "A Classification and Analysis of Certain China Trade Metalwork Types, Including an Examination of Threaded Fastenings" (Phd Dissertation, University of Liverpool, 1995).143, 154-156; A. E. Musson, "Joseph Whitworth and the Growth of Mass-Production Engineering," *Business History* 17, no. 2 (1975): 109–49.

[44] For more details on these various entanglements between designing for global tastes and the material impact of trying to copy models, see H. A. Crosby Forbes et al., eds., *Chinese Export Silver, 1785 - 1885* (Museum of the American China Trade, 1975). Anne Gerritsen, *The City of Blue and White: Chinese Porcelain and the Early Modern World* (Cambridge University Press, 2020). Kyoungjin Bae, "Export Furniture and Artisanal Translation in Eighteenth-Century Canton," *Isis* 113, no. 2 (2022): 310–30. Bae, *"*Joints of Utility, Crafts of Knowledge.*"*

In addition to constructing informal standards, modular approaches to clocks fostered the growth of organizational management for different Chinese trades and materials. Take this example of a typical Nanjing screen clock (see Figure 4-6). This clock is currently held in the National Association of Watch and Clock Collectors. Built likely in the second half of the 19th century, the clock stands nearly 40 cm high from the base. The clock is built to resemble a traditional table screen. It is rectangular and contained within a wooden case and frame designed with a mother-of-pearl inlay. The base of the frame is also richly decorated with carved swirls surrounding floral motifs and geometric patterns. The front of the cabinet is a glass window that reveals the face of the clock. The clock face is a white enamel dial with Roman letters for the hours and Arabic numerals for the minutes. The circular white enamel is inset within an inscribed gilt metal plate. This clock also contains a third hand on the dial that indicates the seconds, although the hand is not centered on the central pivot. The sides of the cabinet have slits as windows so that as one rotates the clock on its stand, one can view the gears turning while the clock is running. The back of the case can be opened and reveals the central mechanism. It is a 14-day brass and steel movement that has a fusée chain and barrel with crown-wheel and verge escapement. The mechanism also contains a gear chain and striking mechanism for a bell.



Figure 4-6: Nanjing-style Screen Clock. This is a typical example of a Nanjing-style screen-clock. The clock is called a screen-clock because the external case is an adaptation of the Ming-period table screen. Note, however, the

similarities in the gilt metal plate, white enamel dial, and the designs of the clock hands with the pirated English-style bracket-clock. Source: Author Image, National Watch and Clock Museum. Ca. 1850. 82.97.1.

Although all these different components were assembled into a final product in the clockmaker's workshop, each of the components came through multiple supply networks. First, enamel dials were specialized products manufactured in Beijing and Guangzhou. In the case of Nanjing clockmakers, according to oral histories of these workshops, they collected the enamel dials through trade networks to Guangzhou. Intermediaries brought turnips from Jiangnan south to Guangzhou, where they traded for the painted enamel dials, which were then brought back to Nanjing. Similarly, Nanjing clockmakers contracted out woodwork to local carpenters in Nanjing and Suzhou who specialized in making the ornate frames used for table screens. Other components were also contracted out to various specialties. The interviewed clockmakers claimed that they distinguished three different types of bells by the quality of the sound and the city associated with it. The metal bells were sourced from foundries in Suzhou, Nanjing, and Yangzhou. The interviewees reported that Suzhou bells were the best quality, but in the late 19th century, they started to rely on bells from Yangzhou, likely because of the impact of the Taiping Rebellion on traditional crafts in Suzhou, although the craftsmen did not offer this explanation. Nanjing makers also said that they sent brass pieces to other workshops for detailed floral motifs, relying on specialists in metal engraving. In the workshop, therefore, the clockmakers focused primarily on producing gears and screws which they employed for compiling the components together into the final table screen clocks.[45]

Additional evidence from extant materials corroborates this practice of cultivating rich local networks grounded on traditional Chinese materials. For instance, in some studies of Chinese clocks, historians have assumed that most of the parts were completely imported and only assembled through the final case. But in Worral's analysis of metal, he identified that some of the bells in English-style bracket clocks were not imported but were cast in China. First, they were made from local supplies of paktong, based on the chemical analysis of the metal alloys. Secondly, some of the bells in these clocks included workshop names on the bells. The bells are made to look and appear like English rounded bells rather than traditional Chinese bells.[46] The workshop names

[45] Song Boyin, "Qing Dai Wei Nian Nanjing Suzhou Zaozhong Shougong Ye Diaocha 清代末年南京蘇州造鐘手工業調查," *Wenwu*, no. 1 (1960): 19–21. 19

[46] Worrall, "A Classification and Analysis of Certain China Trade Metalwork Types." 92-93, Catalogue no. 75

are similar to the same names that were reported in the oral histories as well.[47] If the workshop names had not been there, one might have assumed that these products were imported rather than locally constructed.

In sum, modularity was an important aspect of building and constructing clocks in Chinese workshops. Local makers borrowed and imitated elements from clocks made in other places, but they also adapted these practices to their own local context. They turned to local networks to supply cheaper parts for their own use, and they contributed new applications of these materials that went beyond the original object. Although the limited context of certain machine tools created uneven distributions of standardization, Chinese clockmakers still shared an emphasis on knowing materials and working with those supplies. By their careful experience with different types of products from different contexts, Chinese clockmakers were both cognizant of their local limitations as well as aware of the global context where they sourced their elements.

Workshops as Centers of Clock Repair

In addition to practicing a type of modular and heterogenous approach toward making clocks function, many workshops became centers of clock and watch repair. The focus on repair was probably the most significant form of work for most of the workshops, especially as imported watches and clocks increased in the second half of the 19th century. In other words, while workshops were centers of making, they also can be framed as specialized places for maintenance and ensuring that the larger world of mechanical timepieces continued to function for different users. Making was important, but we need to recognize that workshops in China were more devoted to the maintenance of clocks.

Since the skills and knowledge around using escapements were not widely distributed, watch repair was a significant service that benefited clockmakers beyond their workshops. Zhao Yi 趙翼 (1727-1814), for example, praised clocks for their precision in measurement, but he remarked, "clocks also must be frequently repaired; otherwise, the metal thread inside[48] might go

[47] Song, "Qing Dai Wei Nian Nanjing Suzhou Zaozhong Shougong Ye Diaocha." 19

[48] Jin can literally mean gold. But it is also a classifier for any type of metal product. I prefer to translate the term as metal, because almost all of the "threads" or springs were made from iron and steel not gold.

too fast or too slow."[49] This was then one of the main roles of Western clockmakers in the imperial workshops. In several of their biographies, they wrote about their role in not just making clocks but in trying to repair and maintain the collection.[50] In 1786, after the missionary named "Father Joseph" arrived, he was kept occupied, because he had "many watches in the palace and among the nobles to repair."[51] In his correspondence, the clockmaker Sigismondo discussed how Manchu nobles hired him to fix their clocks and watches at their home.[52]

Chinese workshops throughout the Qing Empire started to expand with these services as well. The Imperial Workshops were involved in this. By the late 18th century, there were already other establishments in Beijing that sold repair services. Hong Daeyong 洪大容 (1731-1783), the Korean visitor to Beijing, wrote extensively about his visits to Liuli chang 琉璃廠, which was a specialty market for art and books. He wrote that there was a sign which advertised watch repair services *xiuli zimingzhong chu* 修理自鳴鍾處 "the place for repairing self-sounding bells." Inside the store one could find examples of clocks and watches. But the proprietor claimed that he did not make them, he only knew how to repair them.[53] This was also the view of visitors to Southern China. In those accounts, authors wrote that Chinese workshops were starting to make clocks, but the shops were described as primarily repair shops.[54]

Similar examples compounded in the 19th century. Some of these shops were centered on treaty ports and advertised their services in newspapers.[55] In Beijing, there were foreign goods stores that sold clocks and watches, and there were other examples of repair shops that were located in Liuli chang.[56] According to later surveys, these shops prioritized repairs over making.[57] In Macgowan's note on Chinese clocks, he also explained that Chinese makers primarily relied on

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[49] "鐘表亦須常修理否則其中金綫或有緩急輒少差" Zhao Yi, *Yanpu Zaji 簷曝雜記 [Miscellaneous Records of the Eaves in the Sun]* (Zhonghua shu ju, 1982). j. 2, 15b, 36. C.f. Menegon, *"*Telescope and Microscope.*"*1330; Bartlett, *Monarchs and Ministers*.209-210; Pagani, *Eastern Magnificence & European Ingenuity*.94

[50] Pagani, *Eastern Magnificence & European Ingenuity*.51, 53, 55, 61

[51] Henri Cordier, "Les Correspondants de Bertin, Secrétaire d'état Au XVIIIe Siècle," *T'oung Pao* 14, no. 2 (1913): 240.

[52] Menegon, "Telescope and Microscope."1333

[53] 琉璃廠有招牌。曰修理自鳴鍾處。入舖要見自鳴鍾。舖主言惟知修理而已。Minjok Munhwa Ch'ujinhoe et al., *Tamhŏnsŏ 湛軒書*, Chaep'an., Yŏngin p'yojŏm Han'guk Munjip Ch'onggan ; 248 (Minjok Munhwa Ch'ujinhoe : Chaep'an parhaeng Kyŏngin Munhwasa, 2001). Waiji, j. 8, 25a

[54] Dobel, *Sept Années En Chine*. 176, 318; Unfortunately, the English edition of this work removed the notes. Dobell, *Travels in Kamtchatka and Siberia*. Macgowan, "On Chinese Horology."336

[55] Li, *Zhong biao, zhong lou yu biao zhun shi jian*.153-154

[56] Yang Jingting , ed., *Du Men Ji Lue 都門紀略* (Jingdu Rong lu tang, 1907). j. 4, 33b-34b

[57] John Stewart Burgess, *The Guilds of Peking* (Columbia University Press, 1928). 113

distributed networks of parts and were mostly employed in repair rather than in constructing new types of movements.[58]

One of the most interesting reports about watch repair came from David Field Rennie (? - 1868). He lived in Beijing and Tianjin in 1860. In late April, Lieutenant-Colonel Edward St. John Neale (1812–1866), who was a secretary in the legation, broke the glass on his watch face. To get it fixed, he asked one of the student interpreters to help him. This interpreter, whose name was Lew Yoong-chuan but who went by the humble name of "See-ou-tee" (*xiaodi* 小弟), was originally from Beijing. He had moved to Shanghai several years before where he had worked for Thomas Francis Wade (1818-1895) and then Joseph Edkins, even visiting the UK with Edkins.[59] Lew brought the watch to local repairers in Beijing. When he returned with the watch a few days later, Rennie wrote in his journal: "To-day he brought it back, going all aright, and refitted with an excellent flat glass. The watches and glasses that the Pekinese deal in are for the most part of Geneva manufacture, imported from Russia, where the Chinese suppose they are made. See-ou-tee showed us one which he himself carries, stating at the same time that 'Roosee-man make-ee it,' which, however, was not the case, the "little-one's" [sic] chronometer being a large-sized Geneva."[60]

Although the import trade impacted the rise of repair shops, Chinese workshops had already started offering this service in different capacities before treaty ports. For instance, the artisans in the imperial workshops were involved in clock regulating.[61] Repair shops could also be found in Fujian by the 1840s.[62] One of the earliest depictions of a Chinese clock shop includes clock repair as a part of the selling services. The image (see Figure 4-7) comes from a collection of export paintings by the Cantonese artist Tingqua Guan Lianchang 關聯昌 (1809-1870). The shop includes several English-style bracket clocks and pocket watches hanging from the walls.

[58] Macgowan, "On Chinese Horology."336
[59] David Field Rennie, *Peking and the Pekingese during the First Year of the British Embassy at Peking*, vol. 1 (J. Murray, 1865). 57
[60] Rennie, *Peking and the Pekingese*, vol. 1. 132-133
[61] Barrow, *Travels in China, Containing Descriptions, Observations, and Comparisons, Made and Collected in the Course of a Short Residence at the Imperial Palace of Yuen-Min-Yuen, and on a Subsequent Journey through the Country from Pekin to Canton*.107, 231
[62] George Smith, *A Narrative of an Exploratory Visit to Each of the Consular Cities of China, and to the Islands of Hong Kong and Chusan In Behalf of the Church Missionary Society, in the Years 1844, 1845, 1846* (Harper and Brothers, 1847).301-302

And the interior of the shop shows two workers involved in fixing internal components and cleaning watch parts.



Figure 4-7: Album Painting of a Clock Shop. This album painting depicts the store front of a clock shop. It is found within several other store fronts from Guangzhou. There are three different types of clocks included in the shop: pocket watches, bracket clocks, and wall-hanging clocks. Source: China: 'A Clock Shop', Canton (Guangzhou). Studio of Tingqua (Guan Lianchang), c. 1830-1840. Bridgeman Images, PFH1185497

Repair services also spread to internal provinces, particularly areas with larger garrisons of Manchus and bannermen. For instance, travelers to Xinjiang mentioned clock repair shops that were already in the region by the late eighteenth century.[63] Travel reports about other Northern frontiers included similar references. One of the late 19th century records about the bannermen in Uliastai, the garrison camp in Mongolia, claimed that the clocks there were cleaned and repaired by Mongolian artisans.[64] The imperial palace additionally maintained a separate set of institutions related to clock repair. Clock maintenance, referred to as *xiuli zhongbiao* 修理鐘表 "fixing and repairing the clocks", was also a practical set of jobs designed for eunuchs in the palace. How many eunuchs worked in this position is unclear. But documents about this position state that there

[63] Ji Yun, *Ji Wenda Gong Yiji 紀文達公遺集*, vol. 1435, Xuxiu Siku Quanshu 續修四庫全書 (Shanghai guji chuban she, 2002). j. 14, 7a, 643

[64] Xiang Lin, *Wu Li Ya Su Tai Xing Cheng Ji Shi 烏里雅蘇臺行程紀事* (Hanji quanwen ziliao ku 漢籍全文資料庫, 1912). Ce 1, 153-154; Ce 3, 74-75; Ce 8, 39

was at least a staff with a head eunuch who managed the clocks, and it continued to be occupied until the end of the dynasty.[65]

There are several biographical accounts that further point to the expanding significance of clock repair skills among artisans in this period. An early account states that Labdun 拉布敦 (? – 1750) from the bordered red banner was a gifted craftsman, respected for his language abilities and technical skills with a bow.[66] According to Zhaolian 昭槤 (1776-1830), Labdun could repair foreign clocks as well.[67] Other extraordinary examples can be found in the biographies of local gazetteers. In the Wujin 武進 county gazetteer, there is an account of a skilled artisan named Sheng Jiuzhao 盛久肇 (dates unknown). He went blind around the age of seven, but he still practiced metalsmithing. He repaired clepsydras as well as mechanical clocks.[68] In the Wu 吳 county gazetteer, there was a person named Guang Shangzhong 管尙忠 (dates unknown). He was an artist and poet, but he was also interested in specialty trades, such as lens-crafting, clock manufacture, and clock repair.[69] Clock repairers can be found in places outside of economic centers too. For example, in the Kaiyuan 開原 county gazetteer, located in northern Liaodong province, there is a record of a person named Zhang Decun 張德純 (fl. 1900). He is described as having limited reading abilities, but he was an expert in understanding internal mechanisms. He could listen to the movement and then look at the parts to identify the problem. Whenever clocks broke down, locals brought them to him and asked him to repair them.[70]

Customs reports which record the import of repair kits similarly indicate that clock repair skills became increasingly important over the century. As clock consumption spread more widely, the skills of clock repair were also a necessary component for regulating and managing these products. Moreover, because European imports remained the majority of watches and then increased from the 1860s onwards, local shops became especially necessary for knowing how to

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[65] *Zhang Gu Cong Bian 掌故叢編*, with Gu gong bo wu yuan Wen xian guan. 故宮博物院文獻館, vol. 7 (1928). 43b; QSL QL 58.7.14, QSL QL 58.7.20; QSL XF 11.10.18; Puyi, *From Emperor to Citizen: The Autobiography of Aisin-Gioro Pu Yi*, trans. William John Francis Jenner (Foreign Language Press, 1989). 62-63

[66] Zhao Erxun, *Qing Shi Gao 清史稿* (Zhonghua shu ju, 1977). j. 312, 10657-10659

[67] Zhaolian, *Xiao Ting Za Lu 嘯亭雜錄 [Miscellaneous Records from the Whistling Pavilion]* (Zhonghua shu ju, 1880). j. 9, 307

[68] *Wujin Yanghu Xian Zhi (Guangxu) 武進陽湖縣志 光緒*, ZGFZK (1879). j. 26, 25b

[69] *Wu Xian Zhi (Minguo) 吳縣志 民國*, ZGFZK (1933). j. 19, 47b-48a, 6685-6686

[70] 性奇巧富於研究性見鐘表留聲機等物一視輒知其機鐶故有此物而廢壞者皆求之修理…其讀書不多僅知名鄉里而已民. *Kaiyuan Xian Zhi (Minguo) 開原縣志 (民國)*, ZGFZK (1917). j. 4, 17a, 413

handle the imported products and how to fix them. This type of relationship that led to a rise in shops and distribution centers that were also stations for fixing can also be represented through the introduction of physical tools. The introduction of foreign clocks was attached to the introduction of repair tools that were centered on European manufactures. Tracking these tools, Li Youru has shown that repair kits and repair tools were introduced at lower rates from about the 1860s. Trade reports indicate that there were about 5,000 to 7,000 repair kits being imported. By about 1900, the number of tools doubled. In the final years of the dynasty into the beginning of the Republican period, tool sets started to be imported around 15,000 sets per year.[71]

To summarize, the introduction of clockmaking was not just about the definition of a new object and manufacture, but it also meant that a suite of skills had to be supplied and constantly engaged with these products to make them functional and useful. Initially, builders and makers were the primary centers for these activities, which continued to limit its expansion. But by the mid-19th century, these skills were able to work in tandem with several other communities to introduce a wider approach and attachment to constructing repair. While the physical infrastructure for constructing clocks may have remained focused on a few central sites, the skills for managing and working with imported products transitioned to give rise to a new type of artisanal workshop that was focused on repair and maintenance.

Social Organization of Chinese Clockmakers

The size and place of the domestic industry in clockmaking mattered. The centers of this trade required combinations of a community of skills and long-term connections with foreign exchanges. This limited the expansion of the trade to wealthy urban centers. Nevertheless, in the second half of the 19th century, clockmaking and clock repair workshops expanded into the interior for several reasons. Firstly, foreign communities and treaty ports overlapped with the desire to produce clocks and sell clocks. Secondly, with better transportation and communication to coastal cities, other centers like Hankou became key sites for mobilizing this labor in a local context, creating additional sets of repair shops that formed guilds and collective organizations for managing repairs.

[71] Li, *Zhong biao, zhong lou yu biao zhun shi jian*.156

Beijing

The city of Beijing was one of the largest centers for Chinese clockmakers, because clockmakers were organized under the imperial workshops in the Neiwufu 內務府 or the Imperial Household. The Kangxi emperor officially instituted specialized workshops dedicated to the production of clocks, and these workshops operated in some capacity until the middle of the 19th century. But the closure of the imperial workshops did not lead to the end of the trade in Beijing. The city remained a prominent center for clockmaking well into the 20th century, because clockmaking penetrated other parts of local culture. These Chinese shops were important for connecting to the older traditions of specialized makers and to the rise of new repair shops that were built in relation to imported watches.

There are few names of individual clockmakers from the early period in Beijing, although we know that clockmaking in the Qing was assigned to bannermen. Specialty crafts, such as clockmaking, often relied on multiple categories of artisans. The most important was the "banner-artisan" families *qijiang* 旗匠. Banner artisans refer to an eclectic set of special banner units that received training in technical crafts. These figures were enrolled in the banner system and military service, and they worked especially for the palace. They were paid for their labor in workshop departments. The banner artisans were not a monolithic group. They included multiple status hierarchies. Some bannermen were independent and participated in the imperial workshops as a government job. Some were eunuchs.[72] Others belonged to the personal bonded class or the *booi*. They came from different ethnic backgrounds, including Manchu, Han, Mongolian, and even Korean artisans.[73] This diversity likely mattered, because it helps explain how Western missionaries found a place in this hierarchy. As a recent study argues, technical labor by Western missionaries was at least initially framed through the notion of personal bondage to the emperor rather than through the European model of courtiers and patronage.[74]

The workshops also recruited special experts in crafts from other regions to work in the capital. One archival document from 1728 names a clockmaker called Zhang Qiongkui 張瓊魁 as

[72] Christine Moll-Murata, "Working the Qing Palace Machine: The Servants' Perspective," in *Making the Palace Machine Work: Mobilizing People, Objects, and Nature in the Qing Empire*, ed. Martina Siebert et al. (Amsterdam University Press, 2021). 51

[73] Teng Deyong, "Qing Gong Zao Ban Chu de Jia Nei Jiang 清宫造辦處的家内匠," *Jilin Shifan Daxue Xuebao Renwen Shehui Kexue Ban*, no. 6 (December 2020): 26–33.

[74] Litian Swen, *Jesuit Mission and Submission: Qing Rulership and the Fate of Christianity in China, 1644-1735* (Brill, 2021).

working in the imperial workshops. He is described as requesting a permit to travel back to his home in Guangzhou which was granted.[75] Another figure named Huang Yiren 黃異人 (late 17th century to early 18th century) worked in the clockmaking units but came from Anhui province. He joined the imperial workshops on account of his mechanical skills. When imported clocks and automata started to increase in the early 18th century, he supported the Kangxi court. He was reportedly able to work with the mechanisms in some of the more complicated automata.[76]

Over time, the imperial workshops changed shape, and the skills started to focus more on repair than making. One of the earliest sources on the size of the workshops was the letter sent by Valentin Chalier (1697-1747), who was managing the clock-making units. In his letter of October 16, 1736, he mentioned that he had a large staff under him. "I have one hundred slave-workers under me who do not hammer a single nail unless I say when or how."[77] In 1769, the missionary clockmaker Jean-Matthieu de Ventavon (1733-1787) wrote about his management: "We do our work quietly in the palace. We have workers there who work under our direction. No one troubles us."[78] Chinese sources in the nineteenth century said that the size of the workshops diminished over time. One of the records from the Jiaqing period claimed that the clockwork workshop had 28 people including the manager and the rest of the general staff. In a later record from the Tongzhi period, the number had increased to 35 people including the manager and the staff. Then by the end of the dynasty, there were only 15 eunuchs classified as clock repairers.[79] Apart from the eunuchs, there were 2 names attached to the palace in the Guangxu period. They were surnamed Kong 孔 and Jiang 蔣 respectively. They managed the various clocks in the palaces, and Jiang was able to work with the musical automata as well.[80]

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[75] Yang Boda, "Shi Ba Shi Ji Nei Yan Guang Jiang Shi Liao Ji Lue 十八世紀清內廷廣匠史料紀略," *Zhongguo Yanjiu Suo Xue Bao* 18 (1987): 121. Gu gong bo wu yuan, *Qing dai Guangdong gong pin , Ku kung po wu yüan, Hsiang-kang Chung wen ta hsüeh wen wu kuan ho paan = Tributes from Guangdong to the Qing court* (Gu gong bo wu yuan, 1987). 27

[76] Liu Dakui and Zhang Peifang, eds., *She Xian Zhi 歙縣志* (1771). j. 15, 147a-147b

[77] "Copy of Letter from Valentin Chalier," Letter, October 16, 1736, Français 17240, fol. 89, Bibliotheque Nationale de France, Département des Manuscrits.; Paul Pelliot, review of *Review of La Montre "Chinoise,"* by Alfred Chapuis, *T'oung Pao* 20, no. 1 (1920): 66

[78] Yves Mathurin de Querboeuf, ed., *Lettres Édifiantes et Curieuses, Écrites Des Missions Étrangeres*, Nouvelle Editions, vol. 24 (Chez J. G. Merigot le jeune, 1781). 114

[79] Liu Yuefang, "Qing Gong Zuo Zhong Chu 清宮做鐘處," *Gu Gong Bo Wu Yuan Yuan Kan*, no. 4 (1989): 52.

[80] Liu, "Qing Gong Zuo Zhong Chu."53

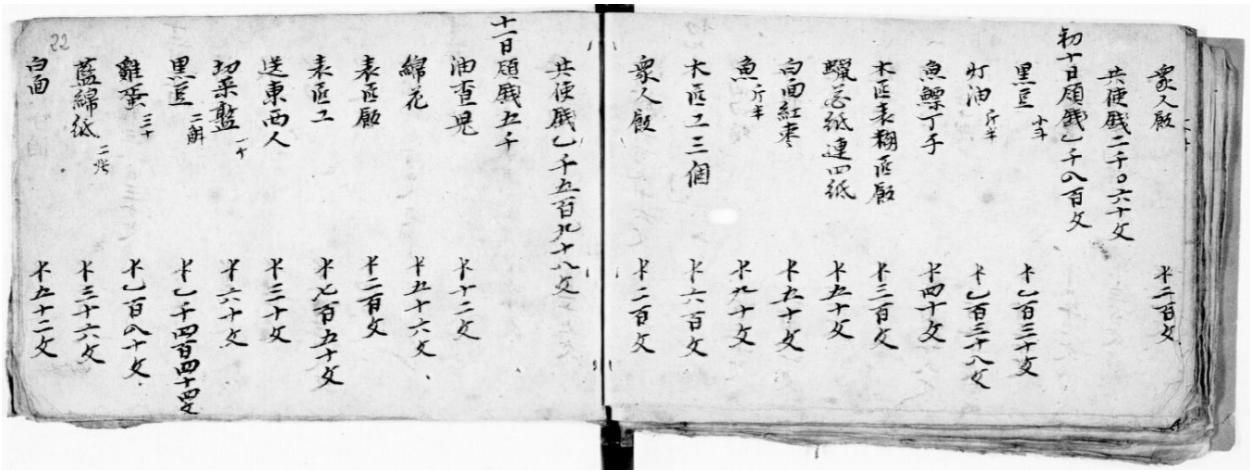

Figure 4-8: Page from Manuscript Chinois 1307. The manuscript Chinois 1307 currently held in the BnF is a book of accounts and local expenses from 1739-1740. The manuscript was likely produced by Valentin Chalier and provides an unusual early insight into life in Beijing. The book of accounts primarily records daily food expenses. Some of the entries record costs about various artisans under Chalier's management. The image above depicts a double-page spread of Day 10 and Day 11 from the 12th month of Qianlong 4 (1740). On day 10, food expenses for "wood", "watch", and "glue" artisans were counted as 300 wen cash. On Day 11, food for "watch" artisans was counted as 200 wen cash. Then, two "watch" artisans received a wage payment of 750 wen cash. Source: M. Sha, "使費帳 Shi fei zhang. Livre de dépenses," Account book, 1739, Bibliothèque Nationale de France, Département des Manuscrits. Chinois 1307, fol. 21v-22r

The imperial workshops provided one of the sources for building a community of clockmakers. In the nineteenth century, the community expanded outside of the palace to the rest of the city. We have already mentioned that one business on clock repair had already existed in Liuli chang since at least the end of the eighteenth century.[81] Yet there were other references that clockmaking remained a small specialty trade practiced within various shops and workshops. By 1863, there were at least thirty-two shops involved in clock repair or clock making in Beijing.[82] These shops were linked together through temple organization and a commercial guild, which was called the Zhongbiao hang shanghui 鐘表行商會 "Commercial Guild of the Clock Trade". Evidence for the guild comes from a temple donation. On the wall of one of the rooms in the Taoist temple complex of the Dongyue miao 東岳廟 Temple of the Eastern Peak, there is an engraving that states that the guild commissioned for a new statue to be built of their founder.[83] This room was the central meeting place for the guild. While the guild recognized Luban as one of the

[81] Minjok Munhwa Ch'ujinhoe et al., *Tamhŏnsŏ*. Waiji, j. 8, 25a; Yang, *Du Men Ji Lue*. j. 4, 33b-34b

[82] Li, *Zhong biao, zhong lou yu biao zhun shi jian*.152; Niida Noboru, Niida Noboru hakuse shū Pekin kōshō girudo shiryō shū 仁井田陞博士輯北京工商ギルド資料集, vol. 4 (Tōyō bunka kenkyūjo, 1983). 760

[83] Ye Guolicheng, *Beiping Dong Yue Miao 北平東嶽廟* (Fuajian jiaoyu chuban she, 2016).34; Niida Noboru hakuse shū Pekin kōshō girudo shiryō shū, vol. 4. 759-760

protective deities related to skilled carpentry, their specific chamber was dedicated to their founding deity named Xianhua zhenjun zhuzu shi 顯化真君朱祖師 "Teacher Zhu, the True Lord of Manifestation". The name carried a Daoist flavor, but it cannot be easily ascribed to a specific deity. The name may have related to an assimilation of Matteo Ricci, the Jesuit who introduced clocks to the Wanli emperor and secured missionary protections in the late Ming. His name might have been attached to the clock guild as a founding deity similar to other craft traditions that were centered around a historical figure and deity.[84]

Even if the community did not rever Ricci as a founding deity, the Beijing clockmakers maintained a long association with the Catholic community of Beijing and foreign missionaries, even beyond the time when missionaries were expelled from the capital. For instance, some Catholic converts served in the Astronomical Bureau when the office was managed by Western missionaries.[85] For the Beitang church located near the Imperial City, Manchu bannermen along with their wives and children were listed among the converts; and some workshop aides were also included in an inventory of servants in residence there in 1778.[86]

Later reports suggest that clockmaking and watch repair in Beijing were associated with Chinese Christians. When David Field Rennie visited the priests and churches in Beijing, he wrote a footnote explaining that Chinese Christians were linked to clock repair. "Christianity amongst the Pekinese seems to run in certain trades. I have since ascertained that the watch-makers and their families are all Christians; which is readily accounted for from their more intimate association with Jesuits, from whom they originally learnt the art of watch-making."[87] Rennie's observation appears to corroborate what is claimed about Beijing Christians in a handbook on local dialect from Beijing. The handbook is a Japanese adaptation of Wade's syllabary, and the textbook provides fictionalized conversations about the city and its sites using vernacular conversation. In one passage, the topic turns towards Chinese Christians.

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[84] Ye, *Beiping Dong Yue Miao*.34; Ji Jianxun, "Shi Cha Shen Cuo: Li Madou 400 Nian Xing Xiang Bian Qian Shi '時'差'神'錯: 利瑪竇 400 年形象變遷史," *Fudan Xuebao (Shehui Kexue Ban)*, no. 6 (2024): 133–45.135-137; Ji Wei, ed., *Tu Jie Zhongguo Guo Su: Hui Gui Zhongguo Ren Zi Ji de Yi Li 圖解中國國俗: 回歸中國人自己的禮儀* (Shaanxi shi fan da xue chu ban she, 2008). 313

[85] Ping-Ying Chang, *The Chinese Astronomical Bureau, 1620–1850: Lineages, Bureaucracy and Technical Expertise* (Routledge, 2023). 57, 59

[86] Eugenio Menegon, "An Invisible City: Urban Life and Networks of European Missionaries and Christian Converts in Qing Beijing," in *From Rome to Beijing: Sacred Spaces in Dialogue*, ed. Daniel M. Greenberg and Mari Yoko Hara (Brill, 2024).53-54

[87] Rennie, *Peking and the Pekingese*, vol. 1. 48

Speaker 1: There are four large halls inside the city walls.

Speaker 2: What are the halls?

Speaker 1: The meeting halls for the Catholic missionaries.

Speaker 2: Do the four churches have names?

Speaker 1: They are named East, West, South, and North. In the city, Dontang (the Eastern Church) is located in the Ganyu Hutong on the north side of the Dongdan placard; Xitang (the Western Church) is located in the main street of the Xizhi gate; Nantang (the Southern Church) is located inside the Xuanwu gate; Beitang (the Northern Church) which is in the Imperial City is located at Canchi kou near the head of the Xi'an gate. The missionaries, since we no longer use them to make the calendar, have left. The churches are locked up. The people who control the locks do not often go in. The Chinese Christians do not gather in the churches now. They do not dare to say that they are Christians.

Speaker 2: What kind of people are they?

Speaker 1: Lots of Christians run snuff shops, bobo shops, and clock shops.

Speaker 2: Are there no poor people among them?

Speaker 2: They do have some poor people. Generally, there are also people who pawn their clothes for holidays but who join the sect hoping to get rich.

Speaker 1: Oh, I see.

Speaker 1: 京城有四個大堂

Speaker 2: 是甚麼堂、

Speaker 1: 傳天主教的會堂、

Speaker 2: 四個堂都有名字麼、

Speaker 1: 有東、西、南、北的名目、在京城那兒、東堂在東單牌樓北甘雨胡同、西堂在西直門大街、南堂在宣武門內、順城根兒北堂在西安門裏頭蠶池口、他們因爲不用他們造曆、回去了各堂就都封起來、把洋樓用磚砌了、攔擋住閒人、不許進去、那些入教的本地人沒了會堂也都不敢言語是教內人了、

Speaker 2: 都是甚麼人、

Speaker 1: 鼻烟舖、餑餑舖、鐘表舖的人多、

Speaker 2: 沒有窮人麼、

Speaker 1: 也有窮人、平素間、典當衣裳過日子想要入教發財的人也有、

Speaker 2: 哦、[88]

The social survey of Beijing included the clock guild as a part of their investigation. According to an interview with one of the members of the guild, the commercial guild began as a business and religious association of Chinese Catholics. The guild was initially composed of converts, who had acquired some skills through missionaries, and who then ran the shops.[89] The guild had practiced Christian rites as a part of their community events. But as more Buddhists joined, they dropped the ceremonial components of their guild meetings.[90] Later reports continued to state that Catholic converts remained the majority of the Beijing clockmakers into the 20th century.[91]

Guangzhou

With their close connection to the imperial workshops, the clockmakers of Guangzhou formed the second most important community in late imperial China. Similar to Beijing, Guangzhou was one of the major sites for contacts with foreigners, and the city produced a plethora of unique artifacts. Although the workshops in Guangzhou did not leave behind a centralized set of records like the imperial workshops, the community did leave behind several traces that can be pieced together to understand that craftsmen started to have skills in clockmaking from an early period, and that they started to form collective units from as early as the eighteenth century. While most records of the community show their local history into the nineteenth century, Guangzhou artisans were also shaped by the growing connections between Guangzhou and Hong Kong from the mid-nineteenth century onward.

Some of the earliest records about clockmaking in China come from Guangzhou, but the documents do not usually point to an established community. For instance, the early Jesuits taught some of the repair skills for the clocks that they brought in the 1580s and 1590s.[92] This may have had some local effect, at least according to different western reports. In the 1640s, Álvaro de Semedo (1585/6 - 1658) praised the people of Guangzhou for their ability to transform materials

[88] Fukushima Yasumasa, *Si Sheng Lian Zhu: Zi Er Ji Ping Ze Bian 四声聯珠: 自邇集平仄編* (1902). j. 7, 45b-46a
[89] Burgess, *The Guilds of Peking*. 141
[90] Burgess, *The Guilds of Peking*. 176-177
[91] Pius L. Moore, "Coadjutor Brothers on the Foreign Missions," *The Woodstock Letters* 74, no. 1 (1945): 16.
[92] Gallagher, *China in the Sixteenth Century*.160-163

in ivory, amber, and gold.[93] He also wrote more broadly that artisans in China, without stating whether he was talking about artisans in Guangzhou, were already making table clocks.[94] Martino Martini (1614-1661) echoed this sentiment but connected it to Guangzhou. In his atlas of China written in the 1640s, he stated that the artisans in Guangzhou were able to copy products from all over the world and had already started making clocks.[95] This news circulated within Franciscan circles as well. According to one of the letters from Guangzhou, the priest wrote that artisans from the South had started to make clocks, a craft that they had learned from the Jesuits.[96]

By contrast, contemporary sources in China from the seventeenth century did not connect local craftsmen to clockmaking. Local gazetteers from the end of the Ming and early Qing did not include clocks as a product. Neither did Qu Dajun 屈大均 (1630-1696), a literatus well-known for his dictionary and compilation about local history of Guangzhou. In that book, Qu mentioned clocks. Except, he only described them in the context of imported articles from Macao. Otherwise, despite plenty of other comments about local manufacturing in Guangzhou, he did not record that local artisans were making clocks.[97]

Although these conflicting reports make it difficult to assess how organized local artisans were in the craft of clockmaking, by about 1715 to 1716, Guangzhou artisans started to proactively incorporate clockmaking into their local products. According to several memorials submitted by the provincial governor of Guangdong Yanglin 楊琳 (1650-1724), he reported that local artisans from the Guangdong enamel workshops had started experimenting with new skills and materials. These techniques were related to several exchanges with incoming missionaries. Some of these exchanges occurred during the papal embassy; other exchanges happened while skilled missionaries waited in Guangzhou before replacing their compatriots in Beijing. According to Yanglin, there was one artisan named Pan Chun 潘淳 who conducted enamel trials. These were trials based on the new types of color and minerals employed by Western missionaries to create vibrant colors. As a part of Pan's experiments, he created an enamel-covered pocket-watch. In

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[93] Alvaro de Semedo, *The History of That Great and Renowned Monarchy of China* (Printed by E. Tyler for I. Crook, 1655).8

[94] de Semedo, *The History of That Great and Renowned Monarchy of China*.27

[95] Jean Blaeu, *Atlas Nuevo de La Extrema Asia, o Descripcion Geographica Del Imperio de Los Chinas* (Chez Jean Blaeu, 1667).163-164

[96] Tang Kaijian and Huang Chunyan, "Qing Chao Qian Qi Xi Yang Zhong Biao de Fang Zhi Yu Sheng Chan 清朝前期西洋鐘錶的仿製與生產," *Zhongguo Jing Ji Shi Yan Jiu*, no. 3 (2006): 119.

[97] Qu Dajun, *Guangdong Xin Yu 廣東新語* (Zhonghua shu ju, 1985). j. 2, 36-37

Yanglin's document, he reported Pan Chun was originally from Fujian province, but Pan had moved to Guangdong to work in the glass industry there. Pan had trained two apprentices named Huang Ruixing 黃瑞興 and Ruan Jiayou 阮嘉猷. Yanglin tested another color artisan named Yang Shizhang 楊士章, whom he determined was a level beneath Pan Chun. Yanglin informed the emperor about these artisans to send them to Beijing. He suggested that Yang Shizhang support Pan Chun at the capital, but he recommended both artisans based on their abilities to make different objects, including clocks and astronomical instruments.[98]

These early exchanges demonstrate that clockmaking was largely subordinate to other crafts industries. This helps explain why eighteenth-century accounts recognized the skills in clockmaking but rarely mentioned specific shops or places that represented a single group of clockmakers. The local gazetteer for the Qianlong period, for instance, explained that Chinese clockmakers existed, although their products were not valued as highly as Western imports.[99] This corroborates how visitors also perceived these workshops.

Nevertheless, clockmaking started to become a more specialized industry in the late eighteenth and early nineteenth century. Local workshops were largely extensions of the imperial workshops in Beijing, and throughout the period, the state increased its demand for clocks.[100] Local merchants started to sponsor the production of clocks as a way to ensure that they could provide clocks even when they were not able to acquire them from foreigners.[101] At the same time, Guangzhou artisans had an increasing level of exchange between local artisans and foreign artisans. These were in part because of the agents set up by local merchants to connect to foreign clockmakers. Such encounters appear periodically in notes about life in Guangzhou. In the private

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[98] Zhongguo di 1 li shi dang an guan, ed., *Ming Qing Shi Qi Ao Men Wen Ti Dang an Wen Xian Hui Bian 明清時期澳門問題檔案文獻匯編*, vol. 1 (Ren min chu ban she, 1999).109-110; Lü Jian, "Kangxi Kuan Hua Fa Lang Suo Yi 康熙款畫琺琅瑣議," *Gu Gong Bo Wu Yuan Yuan Kan*, no. 3 (1981): 93. Emily Byrne Curtis, *Glass Exchange between Europe and China, 1550–1800: Diplomatic, Mercantile and Technological Interactions* (Routledge, 2009),.110-112; Gu gong bo wu yuan, *Qing dai Guangdong gong pin, Ku kung po wu yüan, Hsiang-kang Chung wen ta hsüeh wen wu kuan ho paan = Tributes from Guangdong to the Qing court*. 62-63

[99] Jin Lie and Zhang Siyan, eds., *Guangzhou Fu Zhi 廣州府志 [Guangzhou Prefectural Gazetteer]*, National Library of China (1759), j. 48, 28b

[100] Gu gong bo wu yuan, *Qing dai Guangdong gong pin, Ku kung po wu yüan, Hsiang-kang Chung wen ta hsüeh wen wu kuan ho paan = Tributes from Guangdong to the Qing court*. 63

[101] Huang Qingchang, "Qingdai Guangzhou Zhizao de Xishi Zhongbiao Ji Qi Lishi Beijing Tanxi 清代廣州製造的西式鐘表及其歷史背景探析," *Nanfang Wenwu*, no. 3 (2011): 192-193. ; Leng Dong, "Guangzhou Shi San Hang Yu Qing Dai Zhong Qi Zhong Biao Ye de Fa Zhan 廣州十三行與清代中期鐘錶業的發展," *Lingnan Wenshi*, no. 1 (2012): 49–50.; Louis Dermigny, *La Chine et l'Occident: Le Commerce à Canton Au XVIIIe Siècle*, vol. 3 (S. E. V. P. E. N., 1964). 1237-1240

notes of Ma Guangqi 馬光啓 (fl. earlier than 1840), he met one of the European clockmakers in the Canton factories, whom he claimed was a young boy. The youth had come to China at thirteen and was eighteen at the time of writing. He built one of the large automata that was on sale in the factory warehouse.[102] The presence of European clockmakers and the possibility of cross-cultural exchanges like this would have increased such interactions in these areas.

Furthermore, according to some of the local genealogical sources, families also relied on training clockmaking with other craft skills. The Pan family, for instance, produced important merchants, and they were involved in making clocks. One of the incoming branches of the Pan family produced a genealogy of the migrants from Fujian.[103] One of the family members was named Pan Songxuan 潘松軒. He was included because of his literati status; but the biography also stated that he produced *zimingzhong* clocks. Since his son was born around 1772, this Pan would have arrived in the mid-eighteenth century and would have connected this branch of the Pan family to the emerging network of wealthy Pan merchants originally from Fujian.[104] That some Chinese merchants were invested in the trade as a profession and not just as a distributor is also described in the work of Jeanneret. In his correspondence from the 1820s and 30s, the Swiss clockmaker noted that his friend Windfoung was a Chinese merchant and a part-time clock repairer.[105]

Similar close connections with the foreign community also shaped the history of the Li Zhanji 李占記 brand of clocks. Li Zhanji became one of the most well-known Chinese brands of clockmakers in the South China region by the turn of the century. According to oral histories collected in the 1990s, the family founder Li Lanxin 李蘭馨 (ca. mid-19th century) initially traveled from rural Guangzhou to Hong Kong, where he learned clockmaking from locals.[106] Both

[102] Huang Guosheng ed., *Lingnan Sui Bi: Wai Wu Zhong 嶺南隨筆: 外五種* (Guangdong renmin chuban she, 2015). j. shang, 132-133

[103] Fujian also shared connection with foreign merchants and was known for its clocks. The provincial gazetteer of Fujian in the Qianlong period, for instance, included clocks and compasses as special crafts in this region. For more see, Tang and Huang, "Qing Chao Qian Qi Xi Yang Zhong Biao de Fang Zhi Yu Sheng Chan." 118-119

[104] Tang and Huang, "Qing Chao Qian Qi Xi Yang Zhong Biao de Fang Zhi Yu Sheng Chan." 119-120 ; Pan Gang'er, *Pan Tongwen (Fu) Hang: Guangzhou Shi San Hang Zhi Yi = Tung-Wan/Tung-Fu Hong : Puankhequa I-III : One of the Thirteen-Hongs in Canton 潘同文(孚)行: 广州十三行之一* (Hua nan li gong da xue chu ban she, 2006). 42-43

[105] Auguste Jeanneret-Oehl, *Souvenirs Du Séjour d'un Horloger Neuchâtelois En Chine* (Chez l'auteur, 1866), 42-43.

[106] Mai Guoliang, "Yu Man Ao Kang de Li Zhan Ji Zhong Biao Dian 譽滿粵港的李占記鐘錶店," *Lingnan Wenshi*, no. 1 (1993): 50.

Chinese and foreign merchants were involved in the clock trade in Hong Kong from the beginning of the colony. The 1846 directory, for instance, included German and Swiss watch factories as well as two Chinese brand names in the shopping district.[107] Although Li's family narratives do not state how he learned clockmaking, they claim that after he started learning the trade in Hong Kong, he returned to Guangzhou where he set up his new shop.[108]

Despite the presence of clockmakers, the best evidence for their collective organizing and identity as a "clockmaker" only appeared in the late Qing. For instance, most categories of local making were centered on material products, e.g. ivory, glass, wood, metal. Based on surviving clocks, Guangzhou makers were involved with all of these products, but local lists of trades almost never include a specific category of artisans called "clockmakers" like in Beijing. Instead, local reports only mention that Guangzhou artisans were able to make clocks. The biography of Li also supports this conclusion. Li first learned skills in engraving and welding before he started learning how to repair and work with watches.[109]

Furthermore, although Western visitors left many reports about shopping in Guangzhou, both in the factories and in the city itself, they rarely commented about clock shops. Local visitors described all different types of specialty shops devoted to specific trades and the production of unique artifacts.[110] Clock shops likely did exist but operated on the margins, similar to the world of Guangzhou silversmiths, another group that we know existed but did not merit much comment from foreigners.[111] For example, although foreigners rarely talked about visiting Chinese clock shops in Guangzhou, there are at least two different paintings that are based on store fronts and which explicitly include references to clocks. In addition to the example in the Peabody Museum, the BnF also includes a set of these paintings (see Figure 4-9). I suggest that this painting is perhaps a better illustration for the experience of clocks and watches than an additional source on clock shops. In this series of images, clocks are included in different stores. Both of these stores are not

[107] Anonymous, *Hongkong Almanack and Directory for 1846* (Printed at the Office of the China Mail, 1846).36; Carl Smith, "The German-Speaking Community in Hong Kong 1846-1918," *Journal of the Hong Kong Branch of the Royal Asiatic Society* 34 (1994): 47-48.
[108] Mai, "Yu Man Ao Kang de Li Zhan Ji Zhong Biao Dian."50
[109] Mai, "Yu Man Ao Kang de Li Zhan Ji Zhong Biao Dian."50
[110] Maria Kar-wing Mok, "Trading with Traders: The Wonders of Cantonese Shopkeepers," in *The Private Side of the Canton Trade, 1700-1840: Beyond the Companies*, ed. Paul A. Van Dyke and Susan E. Schopp (Hong Kong University Press, 2018). 64-84; Paul A. Van Dyke and Maria Kar-wing Mok, *Images of the Canton Factories, 1760-1822: Reading History in Art* (Hong Kong University Press, 2015).83-100
[111] For more on silver, see Forbes et al., *Chinese Export Silver*.; Carl L. Crossman, *The Decorative Arts of the China Trade: Paintings, Furnishings, and Exotic Curiosities* (Antique Collectors' Club, 1991). 338-369

explicit clock shops but rather curiosity shops and Western goods stores.[112] Western goods stores were an emerging genre of shops that had started to appear in other locations in China as well.[113] According to one of the records about related Western goods stores, these shops did indeed carry clocks and watches as a part of their stock.[114] Hence, while some artisans used clocks as a part of their new designs for curiosity products, like ivory boats and enamel cabinets, other groups also started to sell more fixed clocks and watches through Western goods stores which were marketed toward domestic audiences.

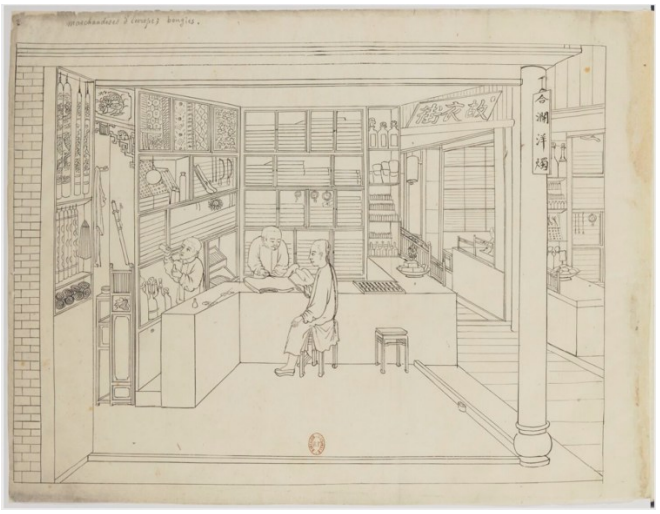

Figure 4-9: Album Painting of European Goods Store. The album contains many different views of shop interiors. This image is called a "European goods and jewelry store". The shelves primarily contain bolts of textiles. But the shelves also include other items, such as guns, bottles (pharmaceutical products?), iron implements, and watches. Source: Yoequa, "Intérieurs de Boutiques," Album Painting, Paris, 19th century, Bibliotheque Nationale de France, Département d'Estampes et photographie. fol. 2r

By the late Qing, the various artisans involved in clockmaking in Guangzhou did organize under the identity of "clockmaker". According to a stone inscription in the center of the old city, clockmakers formed a commercial guild. The guild was based in the heart of the workshop district, and it included a central office for management. Although little information survives about this community and their size, one photograph of the space exists. The space was associated with the

[112] Yoeequa, "Intérieurs de Boutiques," Album Painting, Paris, 19th century, Bibliotheque Nationale de France, Département d'Estampes et photographie. fol. 2r
[113] For some additional context on this transformation, see Dikötter, *Things Modern: Material Culture and Everyday Life in China*.35-36, 54-55
[114] Xiao Yuchun, ed., *Guangning Xian Xiang Shi Tu Zhi 廣寧縣鄉土志* (1908). 53b

Li Zhanji workshop, and the photograph depicted a clock hanging on the wall and different office materials left in the space.[115]

To review, although clockmaking was practiced as a local craft in different capacities in Guangzhou for centuries, the idea of a centrally organized community focused on training and skills only appeared very late in the Qing period. We need to investigate more local sources to better understand the variations in this local trade, and even more about the differences between local makers and their connections with the merchant factories.

Lower Yangzi Region

Clockmakers in China, however, were not limited to contact zones like the merchant networks of Canton and the courtly exchanges in Beijing. Clockmakers also operated independently through networks of skilled craftsmen. One of the most important geographic areas for a separate set of clock workshops was the Lower Yangzi region. This area which included urban centers, like Suzhou, Nanjing, and Hangzhou, was a major economic heartland and center of handicraft industries in late imperial China. While the most famous producers were silk manufacturers, the area also produced other goods in metal, wood, and jade. Chinese clockmakers first appeared here in connection with the Jesuits, and they particularly expanded in the late eighteenth and early nineteenth centuries. Several sources from local gazetteers, published materials, and oral histories have documented how the trade spread and became increasingly independent among the different workshops of the region.[116]

Much like Beijing and Guangzhou, missionary contacts formed an important background to early sources of clockmakers. For instance, in the late Ming period, Li Shaowen 李紹文 recorded that clocks had recently started to be made in Shanghai. He wrote that Ricci had introduced clocks to China, but the local artisans had learned the trade from another missionary, named Lazzaro Cattaneo (1560-1640) when he visited the Shanghai mission for some time.[117] This account is one of the earliest records for the rise of a local trade and community of clockmakers linked with the missionaries. Western sources, however, do not corroborate this account. Firstly,

[115] Guangzhou bo wu guan, ed., *Guangzhou Li Shi Wen Hua Tu Ce 廣州歷史文化圖冊* (Guangdong renmin chuban she, 1996).112

[116] For overviews of clockmakers in Jiangnan, see Tang and Huang, "Qing Chao Qian Qi Xi Yang Zhong Biao de Fang Zhi Yu Sheng Chan." 114-118; Li, *Zhong biao, zhong lou yu biao zhun shi jian*.52-55

[117] Li Shaowen, *Yun Jian Za Shi 雲間雜識* (Shanghai xian xiu zhi ju, 1936). j. 2, 19b

it is not likely that Cattaneo taught these skills. According to the fragmentary accounts of Cattaneo during this period, he did come to Nanjing, but he taught music.[118] Neither was Cattaneo known for clockmaking. Secondly, although the missionary Francois de Rougemont (1624-1676) who was based in Jiangsu province left behind an account book that does cite the name of a clock repairer, we know very little about the context for this person, and where they might have received their skills.[119]

While additional research in missionary archives might illuminate more how Jiangnan clockmakers learned about clockmaking in relation to missionaries and local Christian communities, several biographies from neighboring cities indicate that clockmaking skills did slowly spread among artisans. There were at least two different individuals who were building clocks and spring-driven automata in the early eighteenth century in Nanjing.[120] In Huating, a county just outside of Shanghai, the Xu 徐 family designed and built clocks. They transmitted their skills over several generations and with several different family lines.[121] Furthermore, the city of Hangzhou included some artisans who practiced clockmaking and toy-making already in the late seventeenth century.[122] In 1795, when the Dutch ambassador traveled through Hangzhou, he recorded to his surprise that there were three workshops dedicated to clock repair in Hangzhou.[123] Around the same time, several clockmakers also started to set up shops in Yangzhou, the city that had grown in importance because of its role in the salt trade.[124]

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[118] Liam Matthew Brockey, *Journey to the East: The Jesuit Mission to China, 1579–1724* (Harvard University Press, 2008).59, 295-296; Joyce Lindorff, "Missionaries, Keyboards and Musical Exchange in the Ming and Qing Courts," *Early Music* 32, no. 3 (2004): 405.

[119] Noël Golvers, *François de Rougemont, S.J., Missionary in Ch'ang-Shu (Chiang-Nan) : A Study of the Account Book (1674-1676) and the Elogium* (Leuven University Press, 1999).162, 205, 206, 208, 307, 548-550, 623

[120] Zhang Chao, ed., *Yu Chu Xin Zhi 虞初新志*, XXSKQS (1700). j. 6, 22a-25b, 247-248; Zhou Hui, *Xu Jinling Suo Shi 續金陵瑣事* (1610). j. shang, 41a-41b; Wenfei Wang, "Between Machine and Man: The Question of Creation in the Transmission of Western Mechanical Knowledge in Seventeenth-Century China (A Case Study)," *Ming Qing Yanjiu* 25 (2021):165-169. ; S. E. Kile and Kristina Kleutghen, "Seeing Through Pictures and Poetry: A History of Lenses (1681)," *Late Imperial China* 38, no. 1 (2017): 47–112. Yunli Shi, "Toys and Physics: Introduction of Europe Physics Toys into China and Their Influence," in *Western Influences in the History of Science and Technology in Modern China*, ed. Xiaoyuan Jiang (Springer, 2021). 205-240; Jeffrey D. Lerner and Yaohua Shi, eds., *Silk Roads: From Local Realities to Global Narratives* (Oxbow Books, 2020). 31-48; Shuyong Liu and Zengjian Guan, "Physics Knowledge and Experiments in Ancient China," in *The High Tide of Science and Technology Development in China*, ed. Xiaoyuan Jiang (Springer, 2021). 277-359

[121] Tang and Huang, "Qing Chao Qian Qi Xi Yang Zhong Biao de Fang Zhi Yu Sheng Chan." 115

[122] Xu Yue, *Jian Wen Lu 見聞錄*, XXSKQS (n.d.). j. 3, 32a-33b, 644

[123] André Everard Van Braam Houckgeest, *Voyage de l'ambassade de La Compagnie Des Indes Orientales Hollandaises, Vers l'empereur de La Chine, Dans Les Années 1794 & 1795*, vol. 1 (Chez l'editeur, 1797). 376

[124] Li Dou, *Yangzhou Hua Fang Lu 揚州畫舫錄* (Zhonghua shu ju, 1960). j. 2, 44; j. 12, 282, 270; j. 17, 423

During the Jiaqing period, clockmakers in Jiangnan appeared more in the historical record, and they started to collectively organize under a trade guild as "clockmakers". Several clocks from Nanjing and Suzhou entered the imperial collections as local tribute in this period.[125] In 1825, a local edict in Guangdong specifically referred to the clockmakers of Suzhou and Yangzhou as a category of clock-making communities.[126] Art connoisseurs in the early nineteenth century also defined clocks in relation to four different centers, namely Suzhou, Nanjing, Guangzhou, and Fujian. They referred to these artisans as collective groups associated with the skills.[127]

By 1851, the Yangzi delta contained a variety of shops focused on clock repair and clock design spread through different urban centers. The largest community was in Nanjing, followed by Suzhou, Hangzhou, and Ningbo.[128] In addition to supporting the largest number of clockmakers, Nanjing was probably the origin for much of the expansion in the early nineteenth century.[129] One source of evidence for this connection comes from the clocks. One early Nanjing-style screen clock which has been dated to the Jiaqing period contains internal markings stating that it was built in Shanghai by the Feng 馮 family.[130] Many other clocks labeled as Suzhou or Yangzhou clocks also share this same design pattern. But there are other reasons for this change over time as well. For instance, in studies of the oral histories of the Nanjing community, there

[125] Guo Fuxiang, "Guan Yu Qing Dai de Su Zhong 關於清代的蘇鐘," *Gu Gong Bo Wu Yuan Yuan Kan*, no. 1 (2004): 67-68. ; Nanjing bo wu yuan, *Jing Zhun Yu Hua Mei*.19-22

[126] John Francis Davis, "Two Edicts from the Hoppo of Canton to the Hong Merchants," *Transactions of the Royal Asiatic Society of Great Britain and Ireland* 1, no. 2 (1826): 541–44.541

[127] Qian Yong, *Lü Yuan Cong Hua 履園叢話*, XXSKQS, vol. 1139 (1838). j. 12, 12b, 185; Liang Zhangju, *Lang Ji Cong Tan 浪跡叢談*, XXSKQS (1847). j. 8, 5a-5b, 322

[128] Macgowan, "On Chinese Horology."336

[129] Although some histories of clock-making in Nanjing and Suzhou emphasize the early dates of these communities, such as Pagani, *Eastern Magnificence & European Ingenuity*. 79-80 and Li, *Zhong biao, zhong lou yu biao zhun shi jian*. 52-53, more critical research has questioned some of this chronology. My research has shown that Sun Yunqiu was also making clocks, and therefore contributes a new source for early evidence of clock-making in Suzhou from the seventeenth century. *Qian Long Hu Fu Zhi (乾隆) 虎阜志*, ZGFZK (n.d.). j. 7, 24a, 815. However, that evidence only supports that clocks were already sold and made there in the seventeenth century. It does not fully vindicate the argument for early origins of a community of clockmakers. Guo Fuxiang has argued that the Suzhou and Nanjing clockmakers did not emerge as communities until the early nineteenth century. He has based this argument on re-assessing not only objects, but also the connections made between different historical individuals. For more on this debate, see Xu Wenlin and Li Wenguang, "Tan Qing Dai de Zhong Biao Zhi Zao 談清代的鐘錶製造," *Wenwu*, no. 2 (1959): 34–35. ; Chen Kaige, "Qing Dai Suzhou de Zhongbiao Zhizao 清代蘇州的鐘錶製造," *Gu Gong Bo Wu Yuan Yuan Kan*, no. 4 (1981): 90–94. Guo, "Guan Yu Qing Dai de Su Zhong." 65-77; Tang and Huang, "Qing Chao Qian Qi Xi Yang Zhong Biao de Fang Zhi Yu Sheng Chan." 114-123; Guo Fuxiang, "Guan Yu Suzhou Zhong Biao Zhi Zao de Qi Shi Nian Dai Wen Ti: Dui Tang Kaijian Jiao Shou, Huang Chunyan Nü Shi Zhi Yi de Hui Ying 關於蘇州鐘錶製造的起始年代問題—對湯開建教授、黃春燕女士質疑的回應," *Shilin*, no. 2 (2009): 124–32.

[130] Nanjing bo wu yuan, *Jing Zhun Yu Hua Mei*.134-135

were initially four main families that dominated the trade in the early part of the nineteenth century. In the second half of the nineteenth century and into the twentieth century, the Nanjing community covered more surnames. At least two of these family names overlap with the surnames listed from workshops in Suzhou.[131]

Furthermore, one of the best sources of the Suzhou trade comes from a stele located in the outskirts of Suzhou. The stone inscription is dated to 1816, and it states that the Suzhou clock guild purchased the land as a burial site. Although the names of the clockmakers are not directly related to the same names based on oral accounts, the stele does state that the primary purchaser, a clockmaker surnamed Tang, was originally registered in Nanjing and moved to Suzhou.[132] This corresponds to the way in which clockmakers were reported to build new workshops in oral histories. Based on the training in the workshop, apprentices studied for a few years before they were granted the status of master. Once they were considered a master clockmaker, they were allowed to leave the shop and set up a new shop in a different location.[133]

The clockmakers of Jiangnan maintained relatively small workshops, but they shared some communal features. For instance, both oral histories and textual witnesses commented that the workshops only maintained about three to four workers per shop.[134] Although they created some parts locally, these shops were involved in broader trade networks as well as involved in clock repair. As guilds, they also celebrated a variety of holidays based on their singular identity as clockmakers. They maintained at least one celebration during the Qingming festival to visit the ancestral grave sites and hold a banquet for the different clock-making families.[135] Furthermore, while northern guilds were centered on both the founding deity and the localized craft trade, the guilds of Jiangnan almost exclusively dedicated their trade to Matteo Ricci as the founder of the craft.[136]

These traditional studios also faced competition from a new type of distributor in the late nineteenth century. Following the establishment of the International Settlement in Shanghai,

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[131] Song, "Qing Dai Wei Nian Nanjing Suzhou Zaozhong Shougong Ye Diaocha."19-20
[132] Suzhou lishi bo wu guan, *Ming Qing Suzhou Gong Shang Ye Bei Ke Ji 明清蘇州工商業碑刻集* (Jiangsu ren min chu ban she, 1981).204-205
[133] Song, "Qing Dai Wei Nian Nanjing Suzhou Zaozhong Shougong Ye Diaocha."20
[134] Macgowan, "On Chinese Horology."336; Song, "Qing Dai Wei Nian Nanjing Suzhou Zaozhong Shougong Ye Diaocha."19-20
[135] Chen, "Qing Dai Suzhou de Zhongbiao Zhizao."91
[136] Louis Gaillard, *Croix et Swastika En Chine*, 2nd ed., Variétés Sinologiques ;No 3 (Imprimerie de la mission catholique, 1904).166; Henri Doré, *Manuel Des Superstitions Chinoises; Ou, Petit Indicateur Des Superstitions Les plus Communes En Chine* (Imprimerie de la mission catholique, 1926). 130

distributors of foreign goods started to provide more sources for accessing clocks and repair. One of the best examples of this history is the case of Wang Guangzu 王光祖 (fl. 1915) and the Hengdeli 亨得利 brand name. Originally from a family of tailors, Wang traveled to the International Settlement to work in clothing service. He happened to work on the clothes of a foreign merchant and was given the opportunity to sell watches. He started to make enough money to replace his tailoring business. He raised funds with some additional investors to create the *Hengdeli zhongbiao dian* 亨得利鐘錶店 "Hengdeli Clock Store" in Zhenjiang, Zhejiang province. The business was based on central transportation hubs in the inner river networks and steamboat services. By the 1920s, he had established more shops in Shanghai and most urban centers. The shop specialized in clocks and watches, but it also sold other types of foreign goods.[137]

Other Sites

Although Beijing, Guangzhou, and the various cities of Jiangnan were the most important locations for clock workshops, there were several other sites throughout imperial China where one might find clockmakers. These other locations did not leave significant traces. But based on biographical sources and other local histories, at least some specialized communities started to spread to other places in interior China.[138]

For instance, Fujian province competed with Guangzhou in the early Qing as a center of clock production. I have not seen any clocks labeled as coming from Fujian, but Fuzhou and Xiamen were important centers of global trade before the Qing required trade to center on Canton.[139] Chinese merchants also continued to travel from this site and maintain connections with other emporia like Java and Manilla where they would have encountered other communities of local clockmaking. In the mid-seventeenth century, Zhou Lianggong 周亮工 (1612-1672) published a handbook about administration in Fujian, and he noted that clocks were already being

[137] Wang Yongbin, *Beijing de Shang Ye Jie He Lao Zi Hao 北京的商業街和老字號* (Beijing Yanshan chu ban she, 1999). 116-117
[138] Tang and Huang, "Qing Chao Qian Qi Xi Yang Zhong Biao de Fang Zhi Yu Sheng Chan." 118-119; Li, *Zhong biao, zhong lou yu biao zhun shi jian*.55-56
[139] Dikötter, *Things Modern: Material Culture and Everyday Life in China*.30

produced there.[140] Similarly, the provincial gazetteers described clocks as a local product. We find periodic references to clockmakers in later texts as well.[141]

Another overlooked site was Huizhou 徽州 in the south of Anhui. Early Qing sources state that there were several skilled artisans that started to learn clockmaking and produce a variety of different objects for sale.[142] Connected with both the Yangzi and Pearl deltas, the materials and products could have easily arrived here and produced a local culture of making. Nevertheless, without additional sources, we cannot speak about the size of clockmaking here and whether workshops ultimately gave way to a community.

A similar problem exists in Xinjiang. Although there are several sources that indicate that workshops and clock repairers started to become more popular in the region in the nineteenth century, local sources rarely provide specific information about shops or their locations. Lists of gifts show that Mongols had already started collecting clocks as early as the seventeenth century. The northern trade routes also continued to bring exchanges with mechanisms for local artisans, although there is limited published documentation about this.[143] In sum, while it is not surprising to find that a local community may have been operating out in the frontier, without additional research in archives and local artisan networks, we remain limited in knowing whether these were mostly single cases or a community and local network of clockmakers.

4.2 Market for Clocks, Market for Time

These workshops appeared in key sites of urban and commercial growth in the late Qing. Suzhou and then Shanghai became major financial and economic centers in the empire. Guangzhou remained significant as well. Although in the second half of the nineteenth century, Hong Kong started to replace Guangzhou as the center of foreign trade, Guangzhou remained a key transport

[140] Tang and Huang, "Qing Chao Qian Qi Xi Yang Zhong Biao de Fang Zhi Yu Sheng Chan." 118; Li, *Zhong biao, zhong lou yu biao zhun shi jian*.55

[141] Xie Daocheng, ed., *Fujian Tong Zhi 福建通志* (1737). j. 61, 5b

[142] Shi Zhihong, "Ming Wanli Nian Hou de Zhong Biao 明萬曆年後的鐘錶," *Dong Nan Wen Hua*, no. 6 (1988): 143-144.

[143] Clements R. Markham, *Narratives of the Mission of George Bogle to Tibet, and of the Journey of Thomas Manning to Lhasa* (Trübner and Co., 1876).168; Harry Parkes, "Report on the Russian Caravan Trade with China," *The Journal of the Royal Geographical Society of London* 24 (1854): 308.; Michael Wanner, "Russian-Chinese Trade in Kyakhta — Trade Development and Volume Indicators 1727–1861," *Prague Papers on the History of International Relations*, no. 1 (2015): 20, 23.; Lobsan Yongdan, "Timepieces as Gifts: Exploring European Clocks and Watches in Tibet," *Revue d'Etudes Tibétaines* 57 (January): 87.

and commercial center. Beijing too as the capital formed one of the most significant economic regions of North China. Even some of the less frequently cited locations in clockmaking, such as sites in Anhui, Hubei, and Fujian were all connected to central districts in long-distance trade and commerce. Clockmaking as an industry was deeply entrenched in the networks that shaped merchants and commercialization.[144]

Moreover, clockmakers as a social group benefited from these close associations with the important political and economic centers located across the empire. Artisans had lower prestige according to the traditional scale of the four classes, but clockmakers did not always evince the worst associations.[145] Clockmaking represented a skill that literati tended to value. Elite Manchus tried to learn it, and merchants practiced it as well.[146] Moreover, the evidence inside clocks indicates that clockmakers generally received some literacy training as a part of their apprenticeship or through their family associations.[147] Clockmakers used date inscriptions as a part of their repair, as well as other markings to facilitate the communication of repair. According to later reports, clockmaking was also considered a lucrative profession classified with businesses like pawnshops, banks or jewelry-making.[148] In this sense, horology could be considered as an acceptable trade for local gentry who failed the bureaucratic examination, such crafts that included medicine, seal carving, and inkstone carving.[149]

Since clockmaking offered a mode of respectability for technical craftsmanship, we should not be surprised that clockmakers were also active supporters in constructing and building clocks that resolved problems targeted toward bureaucrats and local gentry. Although many purchasers of clocks were interested in the status associated with a refined and expensive artifact, the changing price of clocks contributed to greater access to these objects. Furthermore, clocks also started to

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[144] For more on commercialization, see Naquin and Rawski, *Chinese Society in the Eighteenth Century*.
[145] Christine Moll-Murata, *State and Crafts in the Qing Dynasty (1644-1911)* (Amsterdam University Press, 2018). 293-319
[146] Auguste Jeanneret-Oehl, *Souvenirs Du Séjour d'un Horloger Neuchâtelois En Chine* (Chez l'auteur, 1866), 42-43 ; Zhao, *QSG*. j. 312, 10657-10659
[147] For some examples, see Abell Auction, "Lot 580 Suzhou Workshop: China Trade Bracket Clock," 580. ; Bedini, "Oriental Concepts of the Measure of Time."456, fig. 4; 460, fig. 7; 461, fig. 9
[148] Doolittle, *Social Life of the Chinese*, vol. 2.157
[149] For more on this context, see Angela Ki Che Leung, "Medical Instruction and Popularization in Ming-Qing China," *Late Imperial China* 24, no. 1 (2003): 130–52.; Chao, *Medicine and Society in Late Imperial China: A Study of Physicians in Suzhou, 1600-1850*.25-52; Ping-Yi Chu, "Family Instructions and the Moral Economy of Medicine in Late Imperial China," *The Chinese Historical Review* 24, no. 1 (2017): 77–92.; Ko, *The Social Life of Inkstones: Artisans and Scholars in Early Qing China*. ; Thomas Kelly, *The Inscription of Things: Writing and Materiality in Early Modern China* (Columbia University Press, 2023).78-133; Michael J. Hatch, *Networks of Touch: A Tactile History of Chinese Art, 1790-1840* (The Pennsylvania State University Press, 2024).118-146

transform as tools for measuring and recording time. Clockmakers did not just fix clocks. They also worked to use clocks to make them meaningful and useful for Chinese markets. Two types of clocks reveal this attention to use: geng-clocks and astronomical clocks.

Geng Clocks

Clockmakers redesigned the mechanics of clocks to fit local contexts. They created clocks that could be adjusted to accommodate seasonal variation. These clocks were closely aligned with the variable hours of the night watch. Chinese models took a different approach compared to Japanese clocks that adjusted time through movable weights, mixed dial plates, and movable hour sizes.[150] Geng clocks were especially designed for imperial contexts and bureaucrats. Nevertheless, these clock designs were important examples in demonstrating how Chinese clockmakers created various solutions to produce clocks that were useful for specific functions.

In 1736, Valentin Chalier described a clock of his design that was meant to accommodate these challenges with variable hours. He had managed the clock workshops since his arrival in 1728.[151] During this earlier period, the workshops had experimented with new designs for frames that were based on Chinese architecture or art motifs, but the time-telling functions remained primarily based on European divisions of time. Then, at some point from 1735 to early 1736, the newly appointed Qianlong Emperor requested that Chalier construct a specialty clock more closely aligned with the state needs for time reporting. The emperor did not just want a clock that announced times during the day, but he wished for a clock that would accord with the drum towers and announce seasonal times throughout the entire year.[152]

To fulfill this request was a challenging technical feat for at least two main reasons. First, the clock had to expand and contract time on a 15-day cycle throughout the year. Public timekeeping with the clepsydra and the drum tower shifted about every 15 days, in accordance with the solar year. The first and last drum announcement marked the time of sunrise and sunset. As a result, from the winter solstice to the summer solstice, the hours of the night contracted as sunset arrived later in the day and sunrise occurred earlier. Then, from the summer solstice to the

[150] For more on Japanese clocks, see N. H. N. Mody, *Japanese Clocks* (Charles E. Tuttle Co., 1967).; Frumer, *Making Time*.
[151] Joseph Dehergne, *Répertoire Des Jésuites de Chine, de 1542 à 1800* (Letouzey & Ane, 1973).166
[152] "Copy of Letter from Valentin Chalier"; Pelliot, review of *Review of La Montre "Chinoise."* 66

winter solstice, the process reversed and slowly expanded. Although these periods shortened and lengthened on a daily level, in practice, the government used the 15-day periods of the 24-seasonal qi as the period of transition. These units of time had their own significance as a kind of audible ritual that changed with one's geographic location and the relationship to one's local time.

However, building a device that could be adjusted for shifting times of sunrise and sunset was only one problem. The second technical problem was the actual rhythm of the drums and their relationship to the hour. Every hour of the night watch had a special drum pattern associated with it. For instance, the initial drum sequence of the evening marked sunset and the signal to switch to the night watch hours. This sequence was not random but defined by precedent. The drummer struck the drums in rounds of 18 beats altering the rhythm with each round. In the first set, the beats were slow or as Chalier described it "posé" (relaxed), while the second set was fast (vite).[153] The drummer alternated the pattern three times in total, resulting in a set of 108 strikes for the first announcement. Then, each subsequent hour had its own special patterns to announce the next hour of the night. Hence, for the second night hour, the drums rang a total of 6 times in a set of 2 strokes per round; for the third hour, 9 times in a set of 3 strokes per round; for the fourth hour, 12 times, in a set of 4 strokes per round; for the fifth hour, 15 times, in a set of 5 strikes per round. Then, the pattern returned to the first with a total of 108 beats in rounds of 18.[154] This was just the template. In practice, it was even more complicated. Around the summer solstice, there were additional hour marks that had to be added and adjusted for the seasonal variations, meaning that there were 10 sets of these patterns on the shortest day of the year, but there were 16 sets of these patterns on the longest day of the year.[155] Compounded with this problem, the designer of the clock had to also adjust the time in minutes and seconds to accommodate the music or rhythmic time of the bells in the clock to coordinate with these shifts. Since each of these patterns had short and long rhythms already included as well as the variations per period followed by the necessary adjustments for each seasonal change, these interlocking cycles were particularly challenging for the clockmakers.

[153] "Copy of Letter from Valentin Chalier"; Pelliot, review of *Review of La Montre "Chinoise."* 64
[154] Wang Qishu, *Shui Cao Qing Xia Lu* 水曹清暇錄, XXSKQS, vol. 1138 (1792). j. 1. 5a, 166; "Copy of Letter from Valentin Chalier"; Pelliot, review of *Review of La Montre "Chinoise."* 64-65; Hung, "Monumentality of Time." 123-124
[155] "Copy of Letter from Valentin Chalier"; Pelliot, review of Review of La Montre "Chinoise." 64-65

As Chalier wrote, "these hours were what gave me the greatest pain to figure out, because nothing is so irregular as the times which separate them."[156]

After four months of experiments, Chalier produced a long-standing clock which supplied the need. The clock stood 4 ½ feet high and was 3 feet wide. The clock included mechanisms that tracked time "a la europeane" with hours, minutes, and seconds; and it included a separate gear train that tracked time in the Chinese fashion.[157] According to Chalier, the emperor was so pleased with this clock that he had it placed in his personal chamber and showed it to the court. The emperor claimed the clock as his own invention and explained it to the ministers who were equally impressed. Although Chalier was disappointed that the emperor had not given him credit, he built two more night-hour clocks which were set up in the palace. These inventions were considered a major achievement and success.[158] According to Amiot (1718–1793) who also happened to see these clocks, he wrote "this work would have passed as a marvel even in Europe, or at least as a work of art."[159]

Night or *geng* hour clocks did not end with Chalier. Based on the archival reports of the workshops and several surviving geng clocks, the Qianlong emperor continued to request imperial artisans manufacture these night clocks. Contrary to Chalier's claim that the clockmakers of the workshops were simply his workers following his orders, and unable to design intricate artifacts like this, most of the records on building geng clocks can be traced from the second half of the eighteenth century after Chalier had passed away.[160] According to the records, similar to other design artifacts in the workshops, the clockmakers responded to the emperor's requests and built artifacts based on his input and taste requirements.[161] These new clocks required complicated sets of springs. In order to ensure that the different systems of counting worked, the clockmakers

[156] "Les Tchuen sont ce qui m'a donné le plus de peine a trouver, par ce que rien n'est si irréguliers pour les tems qui les sépare." "Copy of Letter from Valentin Chalier"; Pelliot, review of Review of La Montre "Chinoise." 65
[157] "Copy of Letter from Valentin Chalier"; Pelliot, review of Review of La Montre "Chinoise." 64
[158] "Copy of Letter from Valentin Chalier"; Pelliot, review of Review of La Montre "Chinoise." 64
[159] "…Père Chalier inventa la fameuse horloge des veilles, ouvrage qui en Europe même, passerait pour une merveille, ou tout-au-moins pour un chef-d'œuvre de l'art." Nicolas Maréchal, ed., *Lettres Édifiantes et Curieuses, Écrites Des Missions Étrangéres.*, vol. 23 (Chez Noel-Etienne Sens, 1811). 292
[160] "Copy of Letter from Valentin Chalier"; Pelliot, review of Review of La Montre "Chinoise." 66
[161] Zhongguo di 1 li shi dang an guan, *Qing Gong Nei Wu Fu Zao Ban Chu Dang an Zong Hui*. Vol. 35, 447, Vol. 45, 166

required multiple mainsprings which were linked to interconnected gear systems. Some of the springs were made in the shop and others were imported from Guangzhou.[162]

One of the extant night-hour clocks from the collections of the Palace Museum in Beijing demonstrates how geng clocks adapted multiple measuring systems to create a new artifact half-way between Chinese and European systems of reckoning (see Figure 4-10). The clock is made from *zitan* sandalwood in cloisonne enamel in an architectural frame of a pavilion with a dual-layered roof. The clock stands 150 cm high on a square base of 70 cm. The architectural structure of the clock resembles a drum or bell tower. Beneath the roof, there is an opening like a window that might have framed the drums in the city tower. In addition to the architectural motif, the clock frame shared other features that soundly connected this design to its Chinese context. The lower base, for example, contained additional architectural references. The base is carved in the pattern of a Sumeru-throne, a motif associated with a Buddhist statue or the foundation of a temple.



Figure 4-10: Palace Workshop Geng Clock. The geng clock is one of the best illustrations of uniquely Chinese clocks. The clock borrows Chinese architectural motifs. The central dial indicators contain multiple systems so that the user can adjust the clock for different intervals. Source: Qianlong period. 150 cm x 70 cm. Beijing Palace Museum, Gu 00183166

[162] Zhongguo di 1 li shi dang an guan, *Qing Gong Nei Wu Fu Zao Ban Chu Dang an Zong Hui*. Vol. 35, 445, Vol. 55, 408

The exterior design, which borrowed from traditional Chinese architecture, was only the first layer. The interior of the clock was formed around an interlocking network of gears controlled by five different mainsprings which powered the functions: 1) marking Western hours and minutes; 2) sounding bells hourly in a 24-hour cycle; 3) sounding bells for quarter and half-hours in a 24-hour cycle; 4) tracking the variation in hours of the night-watch; 5) musical system to announce bells according to the night-watch. The face of the clock accordingly included five keyholes for winding the springs and reported the hours through different sets of dials. The central dial reported Roman numerals for hours and Arabic numerals for minutes. But above the central dial, there were two additional small dials. These dials reported the night-hours and allowed one to adjust the clock for the proper setting. The first dial included the 24-seasonal joints for the year; and, the second dial stated the names of the five hours of the watch. The clock ran for a fortnightly cycle. Consequently, one needed to first set the dial according to the proper seasonal joint. Once fixed, then one would wind the rest of the dials in sequence to set the clock to report the times for the different seasons. When the dial rang, a small automata figure appeared in the open window and struck the bells. The bells rang for all the correct patterns, including the 108 beats for the initial and final times along with the signals for the rest of the night patterns.[163]

There are several additional geng clocks that are based on these structural design features. Firstly, these clocks usually represented miniature models of Chinese buildings and architecture. Secondly, most of the clocks also used at least five springs in order that the user could adjust the settings of the clock to align with the appropriate times of the season.

Using this pattern, the workshops produced modulations. For instance, there is another *geng* clock in the Palace Museum also made from imported woods. This clock stands only about 80 cm high, half the size of the previous clock. The clock is designed like a house. When the wooden door panels open, one can see the yellow enamel plate on the interior. The time units are indicated by the white enamel ring on the interior with Roman numeral hours and Arabic numeral minutes. The clock also has a set of five keyholes for winding the five different functions. On the interior of the ring beneath the positions of the Roman numeral I and XI respectively, there are

[163] See also Guan Xueling, *Ri Sheng Yue Heng: Gu Gong Bo Wu Yuan Cang Qing Dai Zhong Biao 日升月恒：故宫博物院藏清代钟表* (Zi jin cheng chu ban she, 2009). 20-21

two semicircle viewfinders. These viewfinders can be wound and include Chinese hours to facilitate the adjustment of the clock for different seasonal periods.[164]

The workshop built a third clock that miniaturized the drum and bell towers. This night clock is among the largest clocks produced by the workshops. Standing over 300 cm high and nearly 145 cm in width, the clock (see Figure 4-11) is an imposing clock that evokes the bell towers with two stages for three bells and a window in the center that displays the hands of the clock against the large format dial. The clock is built out of *zitan*-sandalwood, and it contains five power systems. The user would open the dial window to wind the five keyholes. However, instead of mainsprings, this large-format clock is based on lead-driven hanging weights. The suspended weights drive the gear system and manage the interlocked system of time indicators and bellringing. There is an iron hammer attached to each of the bells which is activated at the appropriate time. The system strikes the bells on the upper two pavilions for the night watches, the hourly divisions, and the quarter-hours.[165] The clock is a type of mechanical replica for the public timekeeper.



Figure 4-11: Palace Workshop Large-Size Geng Clock. One of the largest clocks in the Palace Collection, this is one of the geng clocks that would have been located near the other tools used for measuring time in the day and night. The

[164] See also Guan, *Ri Sheng Yue Heng*. 34-35

[165] Palace Workshop, *Zi Tan Mu Lou Ge Shi Da Geng Zhong 紫檀木樓閣式大更鐘 Large-Format Geng-Hour Clock Made from Zitan-Sandalwood in the Style of a Pavilion Tower*, Qianlong, Zitan wood, 330 x 145 x 96, Beijing Palace Museum, 00182724.

large-format clock contained multiple bells, and the user would have maintained the clock by winding the keys through the multiple keyholes located in the central dial portion. Source: Qianlong period. 300 cm x 145 cm. Beijing Palace Museum, Gu 00182724

These clocks were set up in various locations throughout the palaces in Beijing to facilitate the marking of time. Inadvertently, these clocks facilitated a transition to mechanical measurement for Chinese hours and replaced the need for managing clepsydras. The palace largely relied on these clocks instead of water clocks. While incense clocks were listed in the supplies for the public time system, the signals that started to control how time information was transmitted from the palace to the city were increasingly managed through these mechanical forms of measurement instead of the water clocks.

But this was not purely a palace-based transformation. Some evidence from clockmakers indicates that clocks calibrated night hours were not restricted to the palace, but other communities of clockmakers also produced clocks like this for bureaucratic offices. In the interviews with the artisans of Suzhou and Nanjing, they reported the different types of clocks that they produced. While the most popular clocks were the Nanjing-style screen clocks, they mentioned that they also produced *geng* clocks. Geng clocks were ordered especially for public offices and local bureaucrats. They were meant to be set up in the local offices to help the local official carry out his duties to submit time signals to the city's public timekeepers.[166]

Beginning in the early nineteenth century, local government offices started to replace some of the clepsydra with such "public clocks." According to Liang Gongchen 梁恭辰 (1814—1887), his family moved to Xiamen in his youth where his father served as a local government official. In his memories of that time, he claimed that the local office contained two clocks that reported times for the office.[167] In 1816, the local gazetteer for Fuliang county, which was the district that oversaw the Jingdezhen porcelain industries, claimed that the local government office used a clock as the public timekeeper. Because of the clock, they reported specific times and their duration in fractions of hours for a reported earthquake.[168]

[166] Song, "Qing Dai Wei Nian Nanjing Suzhou Zaozhong Shougong Ye Diaocha." 19
[167] Liang Gongchen, *Bei Dong Yuan Bi Lu Quan Ji 北東園筆錄全集* (Shan cheng tang shu pu, 1895). Xu bian 續編, j. 2, 12b
[168] *Fuliang Xian Zhi 浮梁縣志 (Daoguang)*, ZGFZK (1823). j. 18, 6a

Moreover, Western reporters in the mid-19th century also claimed that water-clocks had especially fallen into disrepair throughout the empire, and only Guangzhou maintained a consistent use of the water clock for the public system. These reporters stated that one of the places an individual was most likely to encounter a clock in China was the office of the local official. Macgowan claimed that clocks are "confined to the public offices, where it is common to find half a dozen all in a row."[169] And in 1844, George Smith reported seeing a public building with a European dial while also passing through Fuzhou.[170] While these stories do not state that such clocks were necessarily *geng* clocks, the reports do nonetheless point toward the wider shift to integrate mechanical timekeeping in reporting public times.

Astronomical Clocks

Geng clocks connected European and Chinese models of time through interlocking gears. These clocks were not replacing traditional forms of measurement. They complemented it by combining functions into a single object. These geng clocks pointed to the emergence of a time consciousness. This was an awareness that the person used these clocks to measure fixed durations of time. Since time was understood as a variable concept, rather than a fixed category, these clocks enabled adjustment for different moments in the year.

Another clock that illustrated similar shifts toward selling time as a resource and the broader market for time was the astronomical clock or the *tianwen biao* 天文表. The term astronomical clock should not be confused with the observatory instrument called an "astronomical clock" or as it is also called an "astronomical regulator".[171] Those types of clocks were specifically designed for taking precision measurements during astronomical observation. They were set up in such a way so as to maintain the autonomy of the mechanism from external influences that might impact the device, and these types of clocks were more closely associated with chronometers and precision clocks. By contrast, what Chinese users called *tianwen biao* were

[169] Macgowan, "On Chinese Horology."336
[170] Smith, *Narrative of an Exploratory Visit*. 345
[171] Jonathan Betts, "Clock, Regulator," in *Instruments of Science: An Historical Encyclopedia*, ed. Robert Bud and Deborah Jean Warner (Garland Publishing Inc., 1998).121-123; Karsten Gaulke et al., "'The Heavens Daily in View': Planetary Clocks in Europe, Fourteenth to Sixteenth Centuries," in *A General History of Horology*, ed. Anthony Turner et al. (Oxford University Press, 2022).253-272; Denis Roegel, "Astronomical Clocks: Nineteenth and Twentieth Centuries," in *A General History of Horology*, ed. Anthony Turner et al. (Oxford University Press, 2022).273-288

astronomical only insofar as they were related to astronomical topics and information. These clocks were more like mechanical models that represented celestial phenomena. In some sense, they might be more closely compared with simplified orreries or mechanical demonstration instruments. They were not "scientific instruments" in the sense of an astronomical tool used to independently measure celestial phenomena.[172]

Nevertheless, the term is apt, because the name *tianwen biao* was a meaningful actor's category. *Tianwen biao* distinguished astronomical clocks from other categories of clocks. In lists of clocks and instruments, writers described these objects as a specific type. For instance, one of the best documented cases of this is in Xu Chaojun's writings about instruments. When Xu introduced clocks, he categorized devices into two sets. These were "zhong" time-finding by bell or sound and "biao" time-finding by indicators.[173] These terms mapped well to the distinction between "clocks" as a table or mantle timepieces and "watches" as personal devices. But Xu provided additional comments about astronomical clocks under his description of *biao* watches. Following lists of parts, Xu explained how to construct different gear trains. There were several methods one might use to construct a gear train that aligned hours, minutes, and sound alerts for different subdivisions, but each of the procedures started with different sets of teeth used on the gear with a proportional relationship to secondary gears. Some devices, though, required special care.

> I make astronomical clocks [*tianwen biao*]. Each of the quarter-divisions models the appearance of the sun. As it rotates, it aligns with the needle, which points to the sunrise and sunset of the sun throughout the year according to its *jieqi* [position in the annual seasonal movements]. I always use this method.
>
> 余作天文表，刻太陽形模，旋轉以當針，指各節氣太陽出入在何時刻，每用此法.[174]

[172] There is some similarity with various types of planetary clocks. Gaulke et al., "The Heavens Daily in View."253-272. For more information on planetaria and orreries, see Henry C. King, *Geared to the Stars: The Evolution of Planetariums, Orreries, and Astronomical Clocks*, with John R. Millburn (University of Toronto Press, 1978). Tony Buick, *Orreries, Clocks, and London Society: The Evolution of Astronomical Instruments and Their Makers* (Springer, 2020).
[173] Xu Chaojun, "Zi Ming Zhong Biao Tu Shuo 自鳴鐘表圖說," in *Gao Hou Meng Qiu 高厚蒙求*, Bibliothèque nationale de France. Département des Manuscrits. Chinois 4941, by Xu Chaojun (Yunjian, 1815). 1a-2a
[174] Xu, "Zi Ming Zhong Biao Tu Shuo 自鳴鐘表圖說." 8b-9a

As a type of indicator, Xu was explaining that this was a type of internal component that could be added to his clocks. The indicator would not simply show hours, but the internal indicator would show the specific times for sunrise and sunset.

This was not all. Xu went further than simply treating *tianwen biao* as a special type of clock component. He used this separation as a way to classify these clocks alongside other instruments that were used in practicing astronomy. In the final pages of the first editions of his complete collection *Gaohou mengqiu*, Xu included a list of instruments and devices suitable for astronomical practice (see Table 4-1). He prefaced the list with comments explaining that he intended the objects to serve as scientific instruments for individuals to conduct astronomy.[175] Since Xu specifically notes how one might contact him for collecting the various instruments, the list can be viewed as a rare example of a "scientific instrument catalogue" available from 1807 to 1809.[176] The list included celestial and terrestrial globes, sundials, and other mathematical instruments. The astronomical clock is described as a "newly constructed" design. Similar to the later description, he explained that the device was meant to track sunrise and sunset. But in this list, he added that the internal mechanism for the device also reported other times. It included hourly and quarterly notifications as well as aligned with the hours of the night watch, and the times of dawn and dusk. Xu added a note that he had also completed a manuscript that accompanied the device. The manuscript contained additional material about the mechanism with explanations, but it was not yet transcribed for publication at the time he compiled the list.[177] The manuscript does not appear to have survived. But for Xu, astronomical clocks belonged to the entire suite of devices that enabled the astronomer to practice his discipline.

[175] Xu Chaojun, "高厚蒙求, 三集," Print, Tokyo, 1809, Waseda University Library. 儀器目 Yiqi mu, 1a
[176] Chen Tuo, "Cong Xu Chaojun Dao Xu Jiyu: Jia Dao Shi Qi Xin Jiu Xi Xue de Zhi Shi Mai Luo 從徐朝俊到徐繼畬：嘉道時期新舊西學的知識脈絡," *Jin Dai Shi Yan Jiu*, no. 3 (2023): 128-129.
[177] Xu, "高厚蒙求, 三集." 儀器目 Yiqi mu, 1b

Table 4-1: List of Xu Chaojun's Instruments. Source: Xu Chaojun, Gaohao mengqiu sanji, Yiqi mu, 1b

Instrument, Chinese	**Instrument, Translation**	**Description, Chinese**	**Description, Translation**
渾天儀	Celestial globes	漆球木架徑六寸圖說一卷未刊	Lacquered wood stand, 6 cun in diameter; *Illustrated with Explanations*, one volume, not yet published
平儀	Terrestrial globes	漆木為之徑二尺用法已刻	Made from lacquered wood, 2 chi in diameter; *How to Use*, blocks carved
彌綸儀	Milun Instrument (Torquetum)	範銅鏤字圖說並刻	Metal-engraved characters on the exterior; *Illustrated with Explanations*, cut with it
簡平儀	Astrolabe	儀之地盤圖作法用法已刻	Instrument's plates, *How to Make and Use*, already carved
中星儀	Polar-star instrument	表一卷長洲王鐵夫先生作序近與中星儀作法附刊入吳稷堂先生藝海珠塵戊集內	Table, one volume; Changzhou's Mr. Wang Tiefu (Wang Jisun 王芑孫, 1755—1817) prefaced; recently with *How to Make*, added to Mr. Wu Jitang's (Wu Shenglan 吳省蘭, 1738-1810) *Yihai zhuchen* collectanea, wu series
測量儀	Surveying instrument	圖解一卷未刊	*Illustrated and Explained*, one volume, not yet published
圈晷	Ring sundial	高弧表一卷祝萓堂夫子作序未刊	*Table of Latitudes*, one volume; Mr. Zhu Yitang (Zhu Delin 祝德麟, 1742-1798) prefaced, not yet published
到直影晷	Sundial with the straight shadow	定對表一卷桐城張恥庵先生作序未刊	*Table of Measures*, one volume; Tongcheng's Mr. Zhang Chi'an prefaced, not yet published
測晝夜時晷	Dial for measuring times in the day and night	凡二十餘並範銅鏤字其訂譌一卷解(original 捷)說一卷並未刻	More than twenty in all with engraved characters on the exterior; *Corrections and Errors*, one volume; *Explanations*, one volume; not yet published
新製天文表	Astronomical clock, newly built	指逐節氣太陽出入及昏旦五更報時報刻其自鳴鐘表奇器圖說一卷同五更表皆纂稿未謄	Points to the times of sunrise and sunset according to the seasonal qi positions and announces quarterly times, hourly times, the five geng-hours of the night's watch and the dawn and dusk. *Illustrations and Explanations on Marvelous Machines: The Clock*, one volume; together with *Five Geng Hour Table*; both collected and draft, not yet transcribed

算籌	Napier rods	籌算法一卷皆據舊說改註未刊	*Calculating with Rods*, one volume; both edited with a commentary according to the old explanations, not yet printed
雜器	Miscellaneous tools	規四矩一尺一度板一節板一分線板一並以銅製圖法其一卷未刊	Compass, four rulers, one foot, one board of degrees, one board of divisions, one board of divided lines; together with *Illustrations on Making with Brass*, one volume, not yet published

Xu, however, was not the first to use this phrase to refer to a clock or mechanical timepiece that illustrated features associated with astronomy. The phrase *tianwen biao* had previously appeared in the translations of instruments brought by the Macartney Mission in 1793. The phrase was a part of the translation used to define the famous planetarium. Although the mission had also brought an orrery, the translation for the orrery was linked to a table clock. The planetarium, on the other hand, was described as an astronomical clock: *tianwen dili dabiao* 天文地理大表 "large clock of celestial and terrestrial motion".[178] This translation may have impacted Xu's own presentation. According to Xu's book on geography, he was at least familiar with the mission. In his preface, he referenced Macartney's visit to China. It was an illustration of what he referred to as the Qing's openness towards the peoples of the world.[179]

The concept of the astronomical clock was not so much about observation. It instead focused on the popular goal to educate people regarding the astronomical and mathematical cycles that shaped the production of new systems of measuring time. These devices helped communicate this connection by mediating mechanical models of astronomical movement. While clocks may have represented a type of luxury consumption, demonstration models like this showcased how celestial motion might be captured through a mechanical process. These attachments justified time measuring through astronomical collaboration. Furthermore, by connecting celestial motion to a machine, clock designers inevitably raised much more philosophical issues about the nature of

[178] *Zhanggu Congbian*, vol. 7.43b, 44b, 45a-46a; Guo Fuxiang, "Presents and Tribute: Exploration of the Presents Given to the Qianlong Emperor by the British Macartney Embassy," *Extrême-Orient Extrême-Occident* 43 (2019): 43,. 172; J. L. Cranmer-Byng and Trevor H. Levere, "A Case Study in Cultural Collision: Scientific Apparatus in the Macartney Embassy to China, 1793," *Annals of Science* 38, no. 5 (1981): 523–25.
[179] Xu, "高厚蒙求, 三集." 海域大觀自序 Haiyu daguan zixu, 1a-1b

time. Clockwork in this sense offered a material model for understanding the mechanism of change that was so significant in Daoist metaphysics of motive force.[180]

By making astronomical models which shaped the new definitions of time explicit with the astronomical clock, these types of devices brought astronomical perspectives on time to the forefront of measuring and dividing units of time. For instance, it is not a coincidence that Xu Chaojun included multiple treatises on mathematics and sundials next to his collections of clocks. Although clock repair required familiarity with metal and the interaction of different metal components, its own set of craft knowledge, once that work was done, in order to start the clock again, one had to find the time with a sundial. In Xu's words, "For every clock, if it has stopped for a long period of time, it must be adjusted to its local place. When the needle does not match the sun, you must take a sundial and find the hour and the ke. Take the large and small hands of the clock and adjust them to match the sundial. Then, once the clock is running, compare the hands."[181] His point, of course, was that time finding started with different types of instruments. Only after these tools set the time, then one could use the clock which could function in all the different hours and outside of cloudy days.[182] As noted by Macgowan, Chinese clockmakers did indeed carry sundials. They used sundials to regulate clocks and which were more in line with applying the principles of longitude and latitude than other geomantic dials.[183]

Many other clockmakers were also involved in producing astronomical instruments. For instance, some of the earliest clockmakers from Guangzhou were recruited for their abilities to work with gears and enamel. But the reports simultaneously claimed that these artisans should go

[180] Isabelle Robinet, "Primus Movens et Création Récurrente," *Taoist Resources* 5, no. 2 (1994): 40-45.; Farzeen Baldrian-Hussein, "Chen Nan," in *The Encyclopedia of Taoism*, vol. 1, ed. Fabrizio Pregadio (Routledge, 2008).536-537

[181] 凡鐘表久停欲土。針與太陽不對。須將日晷測得時刻將長短針撥對令其走較. Xu, "Zi Ming Zhong Biao Tu Shuo 自鳴鐘表圖說." 19a

[182] Xu Chaojun, "Zi Ming Zhong Biao Tu Shuo 自鳴鐘表圖說," in Gao Hou Meng Qiu 高厚蒙求, Bibliothèque nationale de France. Département des Manuscrits. Chinois 4941, by Xu Chaojun (Yunjian, 1815). Preface, 1a

[183] Macgowan, "On Chinese Horology."340. The production of clocks in the West also led to an increase in sundials and dialing technology, because clock setting also tended to rely on dial technology as a mode of verification. Nevertheless, time standards started to shift more toward mean time as distinguished from solar time, producing sundials with the equation of time and the popular effort to transform everyday understanding that used the clock as the measure for dividing mean hours. For more, see David S. Landes, *Revolution in Time: Clocks and the Making of the Modern World*, 2nd ed. (Belknap Press, 2000).120-122; Anthony Turner, "The Eclipse of the Sun: Sun-Dials, Clocks and Natural Time in the Late Seventeenth Century," *Early Science and Medicine* 20, no. 2 (2015): 169–86.

to Beijing, because they could use their skills to support the making of astronomical instruments.[184] The reported clockmakers from Anhui province gained fame due to their craftsmanship and because they applied their skills towards building astronomical instruments. One such figure listed in the biographies of technical specialists from Xuancheng 宣城 county in northern Anhui Province was named Rui Yi 芮伊 (dates unknown) with the *zi* name Yuquan 與權. He was a skilled craftsman who built clocks. His biography also stated that he had studied Western astronomy based on the hundreds of volumes published about it, likely referring to the imperial textbooks. Accordingly, he was recognized for his knowledge in understanding astronomical measurement and tools. He built various types of "instruments for measuring and comparison", i.e. mathematical instruments, alongside his clocks.[185] Bao Jiayin 鮑嘉蔭 (dates unknown) was a similar case. Registered in She 歙 county in southern Anhui, Bao was from Shuyuan 蜀源 village, a lesser branch of the more famous, neighboring Tangyue 棠樾 village Bao salt merchants.[186] Although not a direct descendent of that branch, Bao Jiayin was involved in the salt trade. According to his biography, he was appointed as the Yuquan 玉泉 salt commissioner of Zhejiang province. He was praised for his knowledge of different technical specialties. He had expert knowledge in astronomy, mathematics, music, painting, medicine, and divination. He built his own celestial globes that were covered with stars; and, he made ingenious clocks, such as a *geng* clock that announced the drum hours at night as well as a *yuezhong* 月鐘 "moon clock".[187]

Like Bao Jiayin, other clockmakers used their astronomical knowledge to produce specialized clocks that combined mechanical operation to measuring and communicating time of different celestial bodies. Although Xu Chaojun referred to his celestial clocks generally as *tianwen biao*, there were other types of clocks that might also be classified under these functions.[188]

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[184] Zhongguo di 1 li shi dang an guan, *Ming Qing Shi Qi Ao Men Wen Ti Dang an Wen Xian Hui Bian 明清時期澳門問題檔案文獻匯編*, vol. 1.109-110; Lü Jian, "Kangxi Kuan Hua Fa Lang Suo Yi 康熙款畫琺琅瑣議," *Gu Gong Bo Wu Yuan Yuan Kan*, no. 3 (1981): 93.

[185] *Xuancheng Xian Zhi (Jiaqing) 宣城縣志（嘉慶）*, ZGFZK (1808). j. 22, 1609

[186] For additional details on the Bao family, see Yulian Wu, *Luxurious Networks: Salt Merchants, Status and Statecraft in Eighteenth-Century China* (Stanford University Press, 2017).127-159

[187] *She Xian Zhi (Minguo) 歙縣志（民國）*, ZGFZK (1937). j. 10, 1719

[188] Jiang Yu also created mechanical globes and clocks, and he called his clock a Perpetual Clock *wannianbiao* 萬年表. Xu Jin and Yang Tingxuan, *Zong Chuan Chi Wen Lu 崇川咫聞錄* (Nantong, 1830), 990055914420203941, Harvard Yenching Library, j. 9, 75b-77b; Wang Bingjun, "Qing Dai Ke Xue Jia Jiang Yu Ji Qi Chuang Zao de Hun Tian Yi He Wan Nian Biao 清代科学家蒋煜及其创造的浑天仪和万年表," *Zhongguo Keji Shiliao* 14, no. 1 (1993): 29–33.

For instance, the Liu 劉 family registered in Anhui's Jingde 旌德 county made different types of clocks used in measuring celestial events. Liu Maoji 劉茂吉 (fl. 1765), also written as *mao* 懋, produced exceptional celestial globes and pendulum clocks along with tables, sundials, and maps.[189] His descendant Liu Shouxian 劉守憲 also made special clocks which demonstrated his superior skills in craftsmanship. According to his biography, these clocks were called "self-sounding bells for the sun and moon" *riyue zimingzhong* 日月自鳴鐘. Like Xu Chaojun's clocks, they produced announcements about the time of an hour and quarters of an hour. The clock included a display that showed the movement of the sun and moon throughout the year and tracked these movements. It also showed the times of sunrise and sunset: "without any errors."[190]

One of the motivations behind these constructions was the need to produce new physical models of time that materialized the differences in standards between the smaller daily units of time in the old calendar and the new calendar. The old Ming calendar used the standard of 100 *ke* to create daily time measurement; but, the new calendar instituted 96 *ke* (defined by 15-minute equal intervals based on astronomical averages).[191] This became the primary standard used to measure a 24-hour cycle. Generally, this was a small change. But it had an impact on everyday life, because the system of *ke* created the equivalence between an average 24-hour cycle and the necessary changes related to keeping night hours. Furthermore, small divisions of the *ke* were particularly relevant for tools that measured durations, such as coordinating the length of time active in a ritual such that the ritual occurred at the appropriate auspicious hour or in measuring activities that had a fixed start and end such as meditation or work tasks.[192] Incense clocks helped guide these actions, because as they burned, they produced the smell that indicated the hour until the wick went out. Such clocks were not useful for finding an hour, but they were suitable for limiting an action to a fixed interval.

One way to understand this is that time finding instruments, such as sundials or the *ganzhi* system were used to show points of time through shadows or the fixed position of a celestial object at a particular time in an annual cycle. Instruments of time duration like clepsydrae and incense

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[189] *Jingde Xian Zhi (Jiaqing) 旌德縣志（嘉慶）*, ZGFZK (1808). j. 8, 75a-75b; *Chong Xiu Anhui Tong Zhi 重修安徽通志*, Xuxiu Siku Quanshu 續修四庫全書 654 (1878). j. 262, 23b

[190] *Chong Xiu Anhui Tong Zhi*. j. 262, 24b

[191] The idea of using 96 ke to measure smaller units of an hour and match them to the hour was not itself new. But the Qing were able to enforce the standard more than previous attempts. Needham et al., *Heavenly Clockwork*.199-202

[192] Robert K. Douglas, *China* (D. Lothrop and Company, 1885).73-75; Bedini, *The Trail of Time*.54-56

clocks, however, were based on fixed measurements from a starting point until the end of the next cycle. These tools did not necessarily measure the same quality, although they were related. And as a result, the two sets of standards had long generated a variety of different solutions for how to equally divide the systems to try to make them equivalent. In sum, these different methods were complementary yet required a variety of different strategies to refer to one another and make them commensurate.

Although incense clocks could be used for fixing the duration of a task rather than directly toward fixing an hour, incense clocks still embedded standards in their construction, because most incense clocks were defined by a measured length in *ke* through the use of the clepsydra and graduated markings.[193] The Astronomical Bureau managed this through its public time functions, submitting these sticks to drum towers.[194] Local timekeepers also created their incense sticks based on the parameters of the Astronomical Bureau. The Luo and Hong families (chapter 2) explained about the new calendar in their prefaces and directly connected this to their production of new artifacts for measuring time.[195] As one pamphlet from the Guangzhou drum tower stated, time sticks were constructed according to the imperial astronomical bureau. Each stick was made based on the times of the clepsydra, and there were different sticks for the day and the night to adjust for changing seasons. One only needed to light the stick at dawn or when one could see the visible lines on the hand, and vice versa at dusk or when one could no longer see the lines on one's hand.[196] Those instructions were important for tracking time, since one could then use the marks divided on the incense stick for measuring the number of *ke* which had passed since dawn or dusk and then compare that to tables to know the hour.[197]

Astronomical clocks and mechanized timekeepers reflected similar shifts in technology as they adjusted and created clocks in line with imperial standards and the shared conception of an hour. They introduced an element of ritual precision in managing personal time. Xu Chaojun explicitly connected these practices to his construction process. In his images of clock parts, Xu

[193] Zhou, *Xu Jinling Suo Shi*. j. shang, 41a ; Bedini, *The Trail of Time*.54
[194] *Yongzheng Da Qing Hui Dian*, Jindai Zhongguo shiliao congkan san bian (1985). j. 246, 8b, 15512
[195] "Chong Dao Tang Luo Zhuan Lie Tong Shu 崇道堂羅傳烈通書," 1831, Libri sin. 707-4, Berlin State Library.; "Hong Chao He Zhang Nan Bin Hai Sun Zheng Zhong Zeng Sun Tang Lin Tong Shu 洪潮和長男彬海孫正中曾孫堂麟通書," 1864, Harvard Yenching Library. Huang Yi-Long, "Tong Shu Zhong Guo Chuan Tong Tian Wen Yu She Hui de Jiao Rong 通書中國傳統天文與社會的交融," *Hanxue Yanjiu* 14, no. 2 (1996): 174-175.
[196] John Henry Gray, *Walks in the City of Canton* (De Souza & Co, 1875). 452
[197] Huang, "Tong Shu Zhong Guo Chuan Tong Tian Wen Yu She Hui de Jiao Rong."175

not only showed the gear trains which aligned with modeling movement on a daily cycle, he also used Arabic numerals to explain it. He added the numbers "96" to explain the teeth on a gear used to construct hours; and he added the numbers "15" in his gears which were used to construct quarter units.[198] These numbers were not random. They were related to the teeth which had to be carved into a gear wheel to create gear ratios that needed to control different units and functions related to the rotations inside the clock.[199] This method impacted other clockmakers too, such as Xu Tai. No relation to Xu Chaojun, Xu Tai was a military student, but he had previously apprenticed in metalsmithing. He was commissioned to make a celestial globe. According to the notes about the globe, Xu also refined his designs of the gear trains with these measurements.[200]

In addition to these sources, oral histories of the Suzhou and Nanjing clockmakers have attested to the presence of specialty dials for explaining astronomical concepts. While not called *tianwen biao*, these artisans produced similar clocks. These clocks were classified as "specialty dial" clocks. The clock was supposed to combine several functions. Some of these special dials included plates with the stems. Others included dials related to the sun and the moon. For instance, the dial indicator for the sun might move slowly throughout the year and indicate sunrise and sunset. The moon dial also might be used to indicate the waxing or waning of the moon throughout the month.[201]

One of the Suzhou clocks from the Palace Museum most likely illustrates an example of what these clockmakers intended by this design (see Figure 4-12). The clock is composed of two main parts. The upper portion is a pavilion and the bottom half is like a bracket-clock. The pavilion is designed according to Chinese architecture and contains an automaton bird. When the clock is fully wound, the bird opens its mouth to sing and shakes its head and tail. The main body of the clock contains four dials and a small compartment on the top with a rotating flower. The largest dial holds the two hands and depicts the hours and minutes in the common format of Roman numerals for the hours and Arabic numbers for the minutes. The three smaller dials contain astronomical information. The two outer dials are European calendar dials. The left dial depicts the days of the week from Monday to Sunday, and the right dial depicts the twelve months of the

[198] Xu, "Zi Ming Zhong Biao Tu Shuo 自鳴鐘表圖說." 6a
[199] Xu, "Zi Ming Zhong Biao Tu Shuo 自鳴鐘表圖說." 7b-8a
[200] *Jiangyin Xian Xu Zhi (Minguo) 江陰縣續志（民國）*, ZGFZK (1921). j.16, 835-839; Jiang Tong, *Li Shenqi (Zhouluo) Nian Pu 李申耆(兆洛)年譜*, Jindai Zhongguo Shiliao Congkan (Wen hai chu ban she, 1969). j.3, 16a-18a, 143-147
[201] Song, "Qing Dai Wei Nian Nanjing Suzhou Zaozhong Shougong Ye Diaocha." 19

year from January to December. These dials are written in English and were clearly appropriated from another clock. The Palace Workshops also confirmed that the clock was combined from different parts. On the back side of the movement, the workshop identified an inscription that stated "10th June, 1868, London". Then, one of the parts also included another label for the "Waterbury Clock Co.", an American-based watch factory in Connecticut.[202]



Figure 4-12: Suzhou-made Clock. The Suzhou clock is built out of a gilt-bronze. The upper pavilion contains an automaton bird that moves and sings. The body contains several dial indicators for minutes and hours and calendar times. The middle dial beneath the white enamel hour dial includes material composed in Chinese. Source: Guangxu period. 131 cm x 69 cm. Beijing Palace Museum, Gu 00182717

While these elements led the investigators to believe that the clock was imported, additional details suggest that other components might have been made in Nanjing or Suzhou, because these secondary characteristics are unique. Although the two lower dials include English material and the Gregorian calendar organization, the third dial in the center is designed completely with Chinese modes of reckoning time. The ring that surrounds the dial contains an engraving of the twelve traditional Chinese hours, similar to the kind of "stems and branches" dial described in the ethnography. Inside the ring, there are two Chinese characters on a red indicator. The characters read *diqiu* 地球 earth. This dial is also a window that simulates the movement of the sun and the

[202] Guo, "Guan Yu Qing Dai de Su Zhong." 74-75

moon. On either side of the small dial, there are sun and moon indicators. The sun piece tracks sunrise and sunset, and the moon shifts according to the lunar phases. In sum, the clock might have been assembled from many different parts – the kind of heterogenous practice noted earlier about workshops – but it still characterized certain features that were meant to be useful for the user.[203]

These clocks displayed popular information about lunar phases and solar movements which would have been of interest to general consumers. Since lunar phrases and the solar positions were so significant for determining ritual times and identifying auspicious dates, these kinds of additional functions on clocks were relevant for most popular users. They translated astronomical information into a mechanical mode that made it accessible and easy to understand. Although these functions might be interpreted as simplistic examples of "astronomical clocks", they would have been an important feature that made the connections between selling time and astronomy explicit for the user. Moreover, these were not the only kinds of timepieces that presented such astronomical information. Clockmakers were also involved in producing other types of devices that demonstrated even more intricate astronomical models which could be used in an individual's home.

There were two other types of astronomical clocks which also functioned as popular tools for displaying astronomical information and marketing that information as useful for measuring the qualities of time. The first was the mechanical celestial globe. Mechanical celestial globes were already in circulation in East Asia by the seventeenth century. One of the earliest examples of a mechanical celestial globe comes from Japan (see Figure 4-13). Borrowing features from new star charts as well as using Japanese systems of hours, the mechanical celestial globe is built on a fixed stand. Like other Japanese clocks, the globe exposes the mechanism highlighting the experience and movement of the object.[204] In China, clockwork celestial globes also appeared during the High Qing period. These large globes are made from gilt bronze. They are highly ornate globes with jewels and pearls used to represent the stars. The globes are also timekeepers. Inside each of the

[203] In his private collection, Silvio Bedini has also shared another multi-dial skeleton clock with similar components. The clock contains misspelled inscriptions, indicating it may have been copied and produced locally. But without being able to know more about the provenance of the clock, I am not sure whether this clock can be thought of as a second example in this genre. Bedini, "Oriental Concepts of the Measure of Time."464

[204] Christopher Cullen and Hiraoka Ryuji, "The Geneva Sphere: An Astronomical Model from Seventeenth-Century Japan," *Technology and Culture* 60, no. 1 (2019): 219–51.

celestial spheres is a movement which rotates the globe. It rotates a clock, dial indicator, and even activates musical features.[205]



Figure 4-13: Geneva Sphere. At the time of the photograph, this mechanical celestial globe was still located in Geneva. On the right portion of the image, there is a gear system which powered the celestial globe. The globe was later sold in the art market. Source: Worrall, "A Classification and Analysis of Certain China Trade Metalwork Types." Plate 21

But the court did not monopolize these devices. Just as the market for clocks spread to a far broader group of educated elites, so too did this impact other types of mechanical demonstration instruments. Biographies indicate that several different artisans were involved in applying their clockwork skills towards manufacturing movable celestial globes.[206] Some of the most remarkable examples appeared in the 1820s to the 1840s. Connected to the world of time reform among Zhang Zuonan and his friends, these celestial globes were initially immobile. Then, Qi Yanhuai asked local clockmakers if they could add clockwork mechanisms to transform the models into a movable clock. According to Jiang Lintai's account, the clockmakers tried several different tests before completing a set of solutions that worked for the globes.[207] These globes were then

[205] Pan Nai, *Colour Printing: The History of Ancient Astronomical Instruments of China 彩圖本：中國古天文儀器史* (Shaanxi jiao yu chu ban she, 2005).222-224; Gu gong bo wu yuan (China), *Qing Gong Xi Yang Yi Qi*.
[206] *She Xian Zhi (Minguo)*. j. 10, 1719; *Jiangyin Xian Xu Zhi (Minguo)*. j.16, 835-839; Jiang, *Li Shenqi (Zhouluo) Nian Pu*. j.3, 16a-18a, 143-147; *Jingde Xian Zhi (Jiaqing) 旌德縣志（嘉慶）*, ZGFZK (1808). j. 8, 75a-75b
[207] "Zhong Xing Yi Shuo 中星儀說," in *Jiang Lintai Ji 江臨泰集*, vol. 3, by Jiang Lintai, Quanshu Gu Dai Dian Ji Cong Shu (Guo jia tu shu guan chu ban she, 2020).1a, 3

produced out of thin sheets of copper and were connected to different sets of gear systems to model the celestial sphere (see Figure 4-14). Most of the clocks included bells to announce different times. Some of the other models included more complicated gear trains. Because these celestial models reflected some of the changes in the star charts studied by Zhang and his coterie of scholars, the celestial globes also included more complicated mechanisms that tried to commensurate a gear train for a solar year with a gear train aligned to a sidereal year.[208] Their work inspired several other makers to create variations on the mechanical celestial globes and market them to a wider audience.



Figure 4-14: Chinese Mechanical Celestial Globe. Here is one example of Qi Yanhuai's mechanical celestial globes. The brass supports can be rotated to adjust the globe for a specific latitude. The dragon-foot stand can also help the user secure the globe. There is a screw that locks the globe in place to hold the position. Source: Qi Yanhuai Copper Celestial Globe. London, Science Museum. Accession Number 1988-1422

The second type of mechanical model that clockmakers helped build was the star clock. While star positions had long been used as a tool for measuring time at night, there were few devices that complemented observation.[209] The Jesuits had translated texts on how to make a nocturnal as one of the instruments included in the dialing tradition, but with the exception of a few examples preserved in the imperial collection, there is little evidence that night-oriented

[208] For more technical details see John H. Combridge, "The Clock-Driven Celestial Globes of Qi Mei-Lu and Others," *Antiquarian Horology* 17, no. 2 (1987): 165–74.

[209] Pan Nai 潘鼐, *Zhongguo Heng Xing Guan Ce Shi 中國恆星觀測史* (Xue lin chu ban she, 1989).120-170; F. Richard Stephenson, "Chinese and Korean Star Maps and Catalogs," in *History of Cartography, Book Two*, vol. 2, ed. J. B. Harley and David Woodward (University of Chicago Press, 1994).533-549; Qiong Zhang, *Making the New World Their Own: Chinese Encounters with Jesuit Science in the Age of Discovery* (Brill, 2015).348-355

dialing instruments ever reached a wide audience.[210] However, in the 1790s, Xu Chaojun first gained notoriety through his publication of what he called the *zhongxing biao* 中星表 the instrument for measuring stars at the meridian. The instrument resembled a type of nocturnal, but it was transformed to meet the function of the much older ritual instrument.[211]

Although Xu Chaojun did not explicitly write that his new device was based on a clockwork mechanism, he referred to it in a similar way as he referred to his "astronomical clock", namely as a type of *biao* and *yi* 儀 instrument. Furthermore, the extant versions of these instruments suggest that these devices were meant to be clockwork models. There are two examples which appear to be star clocks. One is held in the Palace Museum in Beijing, and the other is held in the Oriental Museum of Durham University in the UK (see Figure 4-15).[212] As an astronomical model, these devices display a planisphere of the night sky centered on the north pole, a traditional map used in Chinese ritual. In addition to showing time by the stars, the clocks provide measurements by the position of the sun. The clocks could report hours throughout the entire day and the year. According to those who used these clocks, they were remarkable achievements.

> Regardless if it is day or night, one can know the hour and the ke, and whatever star is in whichever place. It captures the motions of heaven without a hair of difference. The movement of the hours can be known with just a single glance. For more than a thousand years from past antiquity, it is an achievement that has not been possible. It is truly a remarkable success in precision and distinction.
>
> 無論日夜，能知某時某刻某星在某度，毫髮不爽 令天星旋轉，時刻運行，一望而知， 是開千古 以來未有之能事，誠精微之極至矣.[213]

[210] For some illustrations see Gu gong bo wu yuan (China), *Qing Gong Xi Yang Yi Qi*.45-48
[211] Xu Chaojun, *Zhong Xing Biao 中星表*, vol. 42, Cong Shu Ji Cheng Xin Bian (Zhonghua shu ju, 1991). 292-297
[212] Pin Liao, ed., *Clocks and Watches of the Qing Dynasty: From the Collection in the Forbidden City* (Foreign Language Press, 2002).84, fig. 50; "Astronomical Clock," Clock, Durham, Oriental Museum, Eighteenth Century, DUROM.1960.880.; Anne Gerritsen and Giorgio Riello, "The Global Lives of Things: Material Culture in the First Global Age," in *The Global Lives of Things: The Material Culture of Connections in the Early Modern World*, ed. Anne Gerritsen and Giorgio Riello (Routledge, 2016).14-15
[213] Qian, *Lü Yuan Cong Hua 履園叢話*, vol. 1139.13b-14a, 321

These clocks were special, because they combined so many functions of different types of devices into a single device. Furthermore, this was a device that combined the functions of rituals. This meant that it was a kind of marvelous contraption that went beyond simply craftiness to become a useful technology.



Figure 4-15: Chinese Star Clock. The wood frame and design echoes traditional bronze mirrors. Source: University of Durham. Oriental Museum. Accession Number DUROM.1960.880

These comments make it clear that such devices or astronomical clocks were no longer simply objects in the market of clocks but rather tools available within the market for time. These astronomical devices included some aspects of luxury. Some of the celestial globes were covered in silver, and some of style and character writing of the inscriptions on the globes referenced prestigious art forms in the collecting world of ancient bronzes. But more than that, these tools rendered the mysteries of time accessible and visible. By looking at these various types of astronomical clocks, an individual could understand and control fate, as a form of ritual precision. Almanac makers helped contribute to this change. As previously noted, to buy incense sticks was not just about having a tool to measure duration. It was about having a tool so that one might be able to identify qualities and the hours of the eight pillars. By finding hours or determining how long a period had passed from one hour, one might then be able to check that information against calendars to compare the auspicious action and align one's actions within a set of prescribed

activities. This market was the same category that justified these astronomical models. As Qi Yanhuai explained, “This globe takes all the affairs from calculation and inference conducted by experts in astronomy and makes it knowable in a single glance.” It made it possible for anyone in the family to be able to understand and know fate.[214]

In sum, astronomical clocks offered advantages for making time visible to users. The category of *tianwen biao* related to the notion of ritual precision and measurement, and it made that precision individual. Individual users wanted to have faster access to know the kinds of hours and try to adjust their actions to ensure that they cultivated the best possible fate. Astronomical clocks helped make time into a concrete activity. By combining the multiple functions of ritualized tools and measurement tools, these types of astronomical clocks offered multiple approaches for combining and knowing fate. Some of these devices were based primarily on the physical shape of the clock and the simple addition of dial faces that communicated astronomical information. Other examples were more elaborate as they tried to create physical models that guaranteed one had quick and constant access to an accurate demonstration of a larger celestial goal. Astronomical clocks were deeply connected to other types of tools. These clocks continued to point users towards other types of devices for finding such as calendars and lists of auspicious days. But to speak of these new kinds of clocks is to speak of a new kind of market for time. This was not simply buying a device because it illustrated status. Rather this was a purchase that offered a method of control over fate.

4.3 Conclusions

The government official Xu Shijin 徐時進 (1549-1632) received a letter from Beijing that explained how to read the dial face of a clock. The document emphasized that clocks revealed the similarities and differences in indicating hours in China and the West. Chinese and Western hours both measured days, but they divided time into different proportions. The author, possibly Matteo Ricci who was already known to Xu Shijin at the time, explained that Western countries used twelve hours two times a day to find hours, whereas the Chinese used twelve hours for an entire day. “As for the twenty-four hours of that country, they are exactly the twelve hours of China.”[215]

[214] Qi Xueqiu, *Jian Wen Xu Bi 見聞續筆*, XXSKQS (1876). Tian qiu jian shuo 天球淺説, 1a, 5b-6a, 400, 402-403
[215] 為敝國二十四時即中國十二時也 Xu, Jiu Ci Ji 鳩茲集. j. 6, 27a

Moreover, the author continued, one could understand it better if he were to notice the bells. Different sounds throughout the Western hour communicated the shorter units of time. This in turn allowed one to hear ringing so that one might count chimes and recognize the hour, a system that was theoretically cross-cultural if one understood the fundamentals. [216]

Nevertheless, if clocks were supposed to represent universal values of time, Xu did not seem convinced. He understood the principles. But, in a comment at the end of the short pamphlet, he wrote, "I received this material from the capital in the seventh month in the fall of the *jiachen* year of the Wanli reign (1604). According to this, though, if someone were to be born between the hours of *zi* and *hai*, their branch hours would be more difficult to determine."[217] To find the hour of a child's birth in the darkest hours of the night was already a challenge. Shorter hour lengths, with bells at quarter and half-hour divisions, did not simplify the task. The division of units into smaller sections only created more questions in thinking about hours. The greater the detail, the greater the trouble.

Xu's dilemma about the values of time connect to this broader theme: how might clocks be useful tools for Chinese users? The issue was not directly about clocks. Nor was it a case of disregard for time. On the contrary, people cared deeply about time. Throughout my dissertation, I have emphasized the many ways that time mattered: public and private rituals, organizing daily activities, marking special events, and helping predict one's fate. Early clocks, though, did not necessarily communicate the kind of time that could be helpful for supporting these activities. At their core, clocks were supposed to offload challenging tasks of time-finding. Yet early clocks in China only contributed to making time-finding more confusing. They enhanced the awareness of divisions of time, but they did not necessarily indicate easier approaches, a dissonance of multiple rhythms which Henri Lefebvre refers to as arrythmia.[218] These early clocks fascinated court elites due to their autonomous movements. They were richly adorned with rare and expensive gems and materials. As objects themselves, they could indeed mark status. They were luxury products set up on display. But as a cognitive tool, a device for simplifying the actions for finding time, early clocks had trouble meeting local needs.

[216] Xu, Jiu Ci Ji 鳩茲集. j. 6, 27b
[217] 此萬曆甲辰秋七月從京邸寄來者據此則令人之生於亥子間者其日主更難定矣 Xu, Jiu Ci Ji 鳩茲集. j. 6, 27b
[218] Henri Lefebvre, *Rhythmanalysis: Space, Time, and Everyday Life* (Continuum, 2004).16

Chinese clockmakers played a significant role in transforming mechanical clocks into tools for telling time. Although mechanical clocks offered uniform, continuous measures of time, mechanical experts were not searching for monopolies of time. They sought to create useful devices that participated within the broader ecology of time. Clocks prioritized finding time within fixed durations from midnight and noon.[219] Yet time measurement was not characterized by a single artifact. As a public network, Chinese communities accepted multiple media of measuring duration and fixed time more akin to the heterogeneity that characterized work time in early modern York which combined bells, natural cycles, and fixed durations as tools for dividing and measuring labor.[220] Hence, what mattered more was the negotiation of multiple sets of media instead of the predominance of a single object. Chinese clocks only gained significance once they captured other affordances that dominated the role of instruments for measuring time. Rather than clocks determining a transition to uniform visions of time, Chinese clockmakers worked to transform clocks to the standards of fate and local uses in public time information. Clocks had to be evaluated against the standards that determined local divisions of time and measurement.

The two clocks, geng clocks and astronomical clocks, provided compromises that captured mechanical operations yet situated these techniques into specialized audiences that sought solutions for time problems. Clocks that were adjusted for the night hours offered a graded system of tracking hours. They allowed for clocks to align with variable hours of sunrise and sunset, and they remade clocks into local time indicators. These clocks were helpful for managing state institutions that organized local communities around security and watch. But because they encoded local forms of thinking about time, they also limited clocks within specific localities. Since *geng* clocks embedded latitude measurements into their definition, local measurement of time trumped the universal standardizing functions of clocks.

Recall that part of the reason why most *geng* clocks were in the palace is because *geng* clocks had to be calibrated to a specific place. In this sense, night-hour clocks always required calibration with other devices. Even though sites like Suzhou and Nanjing produced examples of these clocks, these clocks had to function within the same government needs that sought to define

[219] Birth, *Objects of Time*.40

[220] In medieval York, work days were generally linked to liturgical calendars, but even this was not fixed. Instead, laborers and managers used multiple sets of media to negotiate different sets of standards and materials for measuring time. In other words, the timescape of medieval England was characterized by its plurality of multiple instruments instead of the dominance of a single instrument. Birth, *Objects of Time*.56-65

local public time. These clocks functioned within lists of times, such as sunrise and sunset. Statecraft reformers like Zhang Zuonan advocated for additional mapping and awareness of slight differences in latitude and longitude in order to encourage government officials to think more critically about the multiple tools involved in these calculations and the incorporation of more precise measurements for rituals (Chapter 3). While clocks simplified the daily responsibilities of tracking these objects, they still interpreted time through the local ecology by which users negotiated the many affordances of different instruments to accommodate specific and in this case legal requirements about public time.

Astronomical clocks also illustrated the ways in which mechanical operations were subsumed within other goals to transform clocks to local timescapes. These clocks took different shapes, and they could sometimes be transported to new locations and had universal functions to make them more mobile. Yet these products also prioritized individual applications of time rather than a universal meaning of time outside of a negotiated community. Astronomical clocks provided guides for measuring fate which required the calibration of multiple natural cycles connected to an individual's own situation. Astronomical clocks contributed to the growth of individual applications and private uses for time. These types of private goals prioritized individual merit and moral action rather than an external measure. Clocks had to resolve other issues of cultural values of time before they had a wider affordance to create coordination to organize around a single artifact.

Nevertheless, both of these examples demonstrate another aspect in the shift toward a market in the broader culture of time. Chinese clockmakers were no longer simply selling clocks as entertaining objects; rather, they were selling devices that simplified tasks for finding and measuring time. *Geng* clocks targeted local bureaucrats and offered one way to offload cognitive burdens. From the eighteenth to nineteenth centuries, local government faced increases in population, demography, and commercialization. These challenges promoted an increase in paperwork and workload. Local offices came to rely particularly on clerks, runners, and other support staff to try to manage the increased tasks. According to one report from 1759, Fujian province alone faced more than 20,000 backlogs of cases.[221] Some famous figures such as Zeng

[221] Bradly W. Reed, *Talons and Teeth: County Clerks and Runners in the Qing* (Stanford University Press, 2000).4; Melissa Macauley, *Social Power and Legal Culture: Litigation Masters in Late Imperial China* (Stanford University Press, 1998).61 For additional context on administrative work and caseloads, see Li Chen, "Legal Specialists and

Guofan were particularly cognizant of personal time management. They created work schedules that partitioned activities for the day, thereby relying on multiple sets of devices to measure their tasks and identify specific hours for when they needed to conduct certain activities.[222] Even merchant apprentices had to rely on schedules of labor that were no longer matched to natural cycles. In the morning, they awakened before regular dawn hours that were associated with other signals like the community belltowers or a rooster's crow.[223] Timekeepers like clocks with alarms and bells offered personal technologies by which individuals could manage their schedules, solve certain issues quickly (such as the hours needed to manage the night's watchmen), and communicate this information within their immediate situation.

Astronomical clocks too sold time expertise as an accessible technology. The most important context for these devices was the market for fate. This market in time was shaped by a growing industry in astrological services and instruments. On special occasions and even on general market days, individuals patronized this industry and asked questions related to time, past, present, and future calculations. Astronomical and demonstration models helped take this expertise and sell it as a specialized tool for use in one's own home. Since the vision here was about the understanding of coordinated cycles, these types of devices supplied a distinct transformation of time into a commodity, yet not one that was centered on work or labor. To purchase a reading required one to understand time as an external measure that was both related to celestial patterns and based on more universal, equal definitions of hours, separated from the variable hours associated with work. This was an attitude toward buying time that continued to allow time to exist as a cycle by which the individual sought to change behavior to align with the environmental cue rather than one in which the clockwork device determined the hour and minute itself.[224]

Judicial Administration in Late Imperial China, 1651-1911," *Late Imperial China* 33, no. 1 (2012): 1–54.; Philip C. C. Huang, *Civil Justice in China: Representation and Practice in the Qing* (Stanford University Press, 1996). 173-181; Bartlett, *Monarchs and Ministers*.; Dykstra, *Uncertainty in the Empire of Routine: The Administrative Revolution of the Eighteenth-Century Qing State*.

[222] Zeng Guofan, *Zeng Guofan Ri Ji 曾國藩日記*, ZGFQJ (Yuelu shu she, 2012). j.2, 319; Zeng Jifen, *Chongde Lao Ren Ba Shi Zi Ding Nian Pu 崇德老人八十自訂年譜* (Jingcheng yin shu ju, 1933). 6a-6b; Zeng Jifen, *Testimony of a Confucian Woman: The Autobiography of Mrs. Nie Zeng Jifen, 1852-1942*, ed. Thomas L. Kennedy (University of Georgia Press, 1993). 23

[223] Lien-sheng Yang, "Schedules of Work and Rest in Imperial China," *Harvard Journal of Asiatic Studies* 18, no. 3/4 (1955): 321-325.

[224] For more on the market for astrology, see Smith, *Fortune-Tellers and Philosophers*.; Hsien-huei Liao, "Critique and Recognition: Mantic Arts and Their Practitioners in the Writings of Song Literati," in *Handbook of Divination and Prognostication in China: Part One Introduction to the Field*, ed. Michael Lackner and Zhao Lu (Brill, 2022).; Stéphanie Homola, "From Jianghu to Liumang: Working Conditions and Cultural Identity of Wandering Fortune-

That clockmakers were able to straddle these two spaces, I suggest, is because of their unique position in the local and global trade of clockwork. Chinese clockmakers, as the emerging experts in managing different systems of time, were acutely aware of their marginality in a global market of time. To work with clocks was to build awareness of different systems of measuring and valuing time. These clockmakers used their access to this industry to construct a unique position within the competition over time information. They lowered costs through business practices that prioritized local materials and the integration of various parts. This type of practice meant that they combined components to create different effects and sometimes built elements from scratch when necessary. Chinese clockmakers acquired a new responsibility in helping translate time and explain how one could read foreign dials and apply multiple systems of time for individual use and personal management.

Tellers in Contemporary China," in *Coping with the Future: Theories and Practices of Divination in East Asia*, ed. Michael Lackner (Brill, 2018).; Stéphanie Homola, *The Art of Fate Calculation: Practicing Divination in Taipei, Beijing, and Keifeng* (Berghahn Books, 2023).; Geng Li, *Fate Calculation Experts: Diviners Seeking Legitimation in Contemporary China* (Berghahn Books, 2019).

Conclusion

Throughout this dissertation, I have posed two questions: how did various instruments impact the attitudes and values around time during the Qing dynasty? What did people *actually* do to render time visible and useful for themselves and their communities? My questions have revolved around several points: First, time tools were essential materials in everyday life because they organized social connections and illustrated imperial authority, but they were also diverse, containing multiple formats and competing standards. Second, the Ming and Qing dynasties oversaw a period of social and cultural change regarding the role of science and technology in the service of the state. From seventeenth- and eighteenth-century innovations in astronomy, mathematics, medicine, and philology to subsequent state-sponsored modernization, industrialization, and Westernization, global exchanges and the circulation of new knowledge transformed how people represented the world and the values that governed such knowledge. Third, for the Ming and Qing, commercialization and emerging markets transformed daily life, whether in terms of the wealth that impacted literacy, publishing, and cultural institutions or in terms of the disruptions to social order which generated alternative sources of authority and opportunities for advancement. Fourth, under the expansion of the state and the rise of new sites for learning, trading zones expanded where people from different backgrounds were able to exchange skills and knowledge for different purposes, ranging from connoisseurship, statecraft, and social mobility. These trading zones included courts, treaty ports, private academies, scholar libraries, art studios, artisan workshops, government offices, and even individual households.[1] The confluence of these factors permitted tools to acquire greater significance for the Qing dynasty. These tools gained new functions, and they provided platforms for their makers to defend their own skills and contributions.

This dissertation has traced the relationships that made public time information in late imperial China. That information emerged through multiple networks. There were historical

[1] Hyeok Hweon Kang has made similar arguments for the role of knowledge in Joseon Korea. Kang, "Crafting Knowledge." For theoretical considerations on the role of trading zones, see Galison, *Image and Logic*. 803-807; Pamela O. Long, *Artisan/Practitioners and the Rise of the New Sciences, 1400-1600* (Oregon State University Press, 2011).; Pamela O. Long, "Trading Zones in Early Modern Europe," *Isis* 106, no. 4 (2015): 840–47.;

traditions that defined the institutions and ideas for what time meant. There were government bureaucrats who oversaw the daily production of time signals and the distribution of tools for lower-level administration. There were artisans who made the tools and enabled them to be distributed to other places. There were entrepreneurs who tried to imagine alternatives that would solve time-related problems. The devices ranged from paper products to environmental signals. And together, these elements formed a material infrastructure, a network that sustained the movement of time information from centers of calculation to public consumption.

The practices and values around calendars, almanacs, sundials, astronomical instruments, and mathematical instruments discussed in the previous chapters demonstrate the complexity around making public time in the Qing dynasty. Time materials did not necessitate a single theory of time, nor did they automatically reflect a particular assumption about that time. Time tools were interconnected objects, and they situated the making of time in a particular moment and place. Time devices had to be imagined and made. They were not independent artifacts. This sense of contingency and interdependence highlights one of the central arguments made throughout this dissertation, namely that the materiality of time generated possibilities. These moments of materialization could reproduce larger structures and reimagine them. Thus, almanac makers could use imperial calendars to market their skills and distinct expertise in the wake of official calendars, while also upholding larger themes of orthodoxy in selling marriage divinations and geomantic interpretations. Clockmakers too could create clocks to gain wealth through selling exoticism and wondrous experiences even as they experimented with using clockwork technology to unify the different modes of counting and recording time in traditional China. The materialization of time represented specific choices that had multiple consequences.

To conclude, let me summarize three insights about the significance of this project and its impact. These points emerge from each of my chapters, and they demonstrate how thinking through material infrastructures can make a difference in our narratives about culture in late imperial China. The three points are: 1) circulation of knowledge; 2) value of precision; and 3) market for time. I will tackle these points in the following sections.

Circulation of Knowledge

First, this dissertation fills in a gap in our understanding about the circulation of scientific knowledge in the early nineteenth century. I have demonstrated that at least three different social

groups—almanac makers, clockmakers, and statecraft reformers—continued to engage with Western astronomical knowledge and remake it for local audiences. For almanac makers, the study of imperial mathematics and astronomy were the sources of their calendrical authority (chapter 2). These makers understood that the content of this knowledge had changed with the introduction of calendar reforms. They were also aware that even earlier ideas had changed over time. There were ongoing updates to the calendar that allowed for greater measures of precision and calculation. For these families, private businesses, and even individual compilers, the study of astronomy allowed them to create useful materials that interpreted the calendar for their local audiences. Whether in private consultations, their printed works, or their tools of timekeeping, these groups treated time as a practical science grounded in astronomical concepts. Proper understanding of mathematics and astronomical information were fundamental parts of their identity as almanac makers, but they were also practical skills that allowed them to practice their trade.

Clockmakers also used practical applications for astronomical concepts. Basic principles of astronomy were critical to the design of clocks (chapter 4). Even though many Chinese clockmakers prioritized clock repair, they still produced clocks of their own design. Clockmakers did not treat their products as merely elite entertainment. This is not to deny that clocks could have social significance beyond time measurement. The consumption of clocks followed a longstanding pattern by which the fashions of court trickled down to lower levels of society. Just as the Beijing court used clocks as wall and table decorations, families imitated this design practice in their own homes.[2] With pocket-watches, elites collected these goods through their connections to foreign trade. These objects were displayed as showpieces, meant to impress others about their intricacy and luxury design. As so many observers remarked, pocket-watches were obviously signs of social status.[3] By the second half of the nineteenth century, when timepieces became more affordable, they also started to index other forms of modernization and Westernization. To own a watch was a sign of one's commitment to modernity.[4]

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[2] Pagani, *Eastern Magnificence & European Ingenuity*. 89-91, 94-96; Li Youru, *Zhong biao, zhong lou yu biao zhun shi jian: xi shi ji shi yi qi ji qi yu Zhongguo she hui de hu dong (1582-1949) 鐘錶, 鐘樓與標準時間: 西式計時儀器及其與中國社會的互動 (1582-1949)* (Zhengzhi daxue lishi xi 政治大學歷史系, 2012). 69-72

[3] Li Youru, *Zhong biao, zhong lou yu biao zhun shi jian: xi shi ji shi yi qi ji qi yu Zhongguo she hui de hu dong (1582-1949) 鐘錶, 鐘樓與標準時間: 西式計時儀器及其與中國社會的互動 (1582-1949)* (Zhengzhi daxue lishi xi 政治大學歷史系, 2012). 73-75, 84-88

[4] Dikötter, *Things Modern: Material Culture and Everyday Life in China*. 184-185, 214; Li Youru, *Zhong biao, zhong lou yu biao zhun shi jian: xi shi ji shi yi qi ji qi yu Zhongguo she hui de hu dong (1582-1949) 鐘錶, 鐘樓與標*

But these forms of consumption do not negate the fact that clockmakers themselves treated clocks and watches as practical timepieces that solved cognitive problems related to knowing the time. When makers constructed their clocks, they used familiar symbols and structures such as the bell tower to connect their design to more common modes of measurement. They used clocks to demonstrate astronomy. Many clockmakers were even involved in explicit instructions about how to use clocks. They provided translations of dial faces and pamphlets that were meant to support the purchase. Clockmakers were cultural intermediaries like other translators as they informed consumers about mechanical modes of time.

For scholar-gentry, astronomical knowledge also mattered. Philologists studied astronomy to recover past knowledge. These skills supported the interpretation and validation of classical texts. Many scholars also used these techniques to construct longer histories of time. They studied astronomical systems to build historical chronologies.[5] These techniques were not restricted to the evidential schools of philology and Han Learning. Traditionalists turned to astronomy and mathematics too. The Changzhou school of New Text Confucians encouraged scholars to use astronomy and mathematics as a part of their training.[6] In Guangzhou, Chen Li 陳澧 (1810–1882) supported Song-learning metaphysics within *kaozheng* methods. He too taught astronomy and mathematics.[7] Wang Jiabi 王家弼 (fl. 1832-1834), who publicly criticized national elites for abandoning the moral training of the Song scholars, used new mathematics and astronomy to enhance his commentaries about the *Book of Changes* and classical metaphysics.[8] Mathematical astronomy offered precision in method even as intellectual traditions debated their interpretation.

These knowledge exchanges involved ongoing updates and evaluations of knowledge, not simply the repetition of past learning. Historians have emphasized that Chinese intellectuals

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準時間: 西式計時儀器及其與中國社會的互動 (1582-1949) (Zhengzhi daxue lishi xi 政治大學歷史系, 2012). 132-148, 163-166

[5] In constructing historical timelines, scholars used astronomy and mathematics to create these analyses. Fan Jingfu 范景福 (? - 1816), Lei Xueqi 雷學淇 (fl. 1814), Zhang Dunren 張敦仁 (1754-1834), Yu Huang 餘煌 (fl. 1798-1814), and Mao Yingguang 毛應觀 (fl. 1835-1838) are just a few examples. For critical evaluations on historiography and its meaning in the Qing, see Q. Edward Wang and On-Cho Ng, *Mirroring the Past: The Writing and Use of History in Imperial China* (University of Hawai'i Press, 2005). 223-258

[6] Benjamin A. Elman, *Classicism, Politics, and Kinship: The Ch'ang-Chou School of New Text Confucianism in Late Imperial China* (University of California Press, 1990), 120-121.

[7] Stephen B. Miles, *The Sea of Learning: Mobility and Identity in Nineteenth-Century Guangzhou* (Harvard University Asia Center, 2006). 206-207

[8] *(Guangxu) Yancheng Xian Zhi（光緒）鹽城縣志*, ZGFZK (1895). j. 12, 872-877; Wang Jiabi, *Tian Xue Chan Wei 天學闡微*, Xuxiu Siku Quanshu 續修四庫全書 1035 (1885).

engaged with global science and technology under two distinct regimes of "Old" and "New" Western Learning.[9] The first came through Catholic missionaries, and it reached its height during the eighteenth century. Starting from the late Ming, missionaries translated early modern literature on science and technology, and they created new instruments for reforming the calendar. With the Qing, foreign missionaries occupied government positions through the Astronomical Bureau and the Imperial Workshops, and they facilitated global exchanges as they connected their mission houses with other scientific organizations and academies. Yet many factors limited their significance, including the Qing's religious policies, the missionaries own selective choices towards what to teach, and the internal debates among religious groups and the differences in their approaches. The end of the mission is therefore treated as a dividing point in contact and exchange under "Old" Western Learning.

"New" Western Learning, however, came through Protestant missionaries and then secular officials involved in diplomacy, modernization, and reform. Protestant missionaries criticized the older translation movement, and they started publishing new material from the outset. Robert Morisson was the first to start these efforts followed by Karl Gutzlaff and others. Major figures involved in the translation projects therefore included Alexander Wylie, Joseph Edkins, and then John Fryer. More recent historiography has also raised the case that these translations depended on local Chinese figures, such as Xu Shou, Xu Jianyin, Hua Hengfang, Li Shanlan, and Yan Fu. Even though these two periods overlapped in the first decades of the nineteenth century, intellectual historians have tended to view them as separated, whether because of their distinct

[9] This is a powerful paradigm in Chinese intellectual history. Fang Hao, one of the pioneers of studying the history of Sino-European relations, used 1800 as his cutoff between different relations. Fang Hao, *Zhong Xi Jiao Tong Shi 中西交通史*, vol. 2 (Shanghai ren min chu ban she, 2008). 487-488. Ge Zhaoguang similarly uses the nineteenth century to divide intellectual transitions between "Old Western Knowledge" and "New Western Knowledge". Ge Zhaoguang, *Zhongguo Si Xiang Shi: Dao Lun Si Xiang Shi de Xie Fa 中國思想史: 導論思想史的寫法* (Fudan daxue chuban she, 2001). 446-476; Ge Zhaoguang, *An Intellectual History of China, Volume 2: Knowledge, Thought, and Belief from the Seventh through the Nineteenth Century*, trans. Josephine Chiu-Duke and Michael S. Duke (Brill, 2018). 267-282. For more scholarship on this intellectual division, see Bao Chengguang, *Xi Fang Wen Hua Yu Zhongguo She Hui: Xi Xue Dong Jian Shi Lun 西方文化与中国社会: 西学东渐史论* (Jilin jiao yu chu ban she, 1994).; Xiong Yuezhi, *Xi Xue Dong Jian Yu Wan Qing She Hui 西学东渐与晚清社会* (Shanghai ren min chu ban she, 1994), Xi xue dong jian yu wan qing she hui.; Xiong Yuezhi, *The Eastward Dissemination of Western Learning in the Late Qing Dynasty*, 2 vols. (Silkroad Press, 2013).; Zou Zhenhuan, *Xi Fang Chuan Jiao Shi Yu Wan Qing Xi Shi Dong Jian: Yi 1815 Zhi 1900 Nian Xi Fang Li Shi Yi Zhu de Chuan Bo Yu Ying Xiang Wei Zhong Xin 西方传教士与晚清西史东渐：以 1815 至 1900 年西方历史译著的传播与影响为中心* (Shanghai gu ji chu ban she, 2007).

institutional backgrounds or because scholars sought to emphasize the exogenous factors that changed intellectual history.[10]

Yet this framework has struggled with how to accommodate almanac makers, clockmakers, and even statecraft reformers like Zhang Zuonan under the categories of science and technology. William Milne, for instance, negatively compared *tongshu* to Old Moore's Almanac.[11] Alfred Lister and Alvin Parker similarly bemoaned the popularity of almanacs as a sign of superstition.[12] This negative attitude toward almanacs from the advocates for Western Learning continued unabated into the twentieth century. Books like almanacs were central points of discussion in questions about reform and modernization. For many late Qing and early Republican-era critics, almanacs were the exemplars of outdated epistemology.[13] In recent decades, the value of these sources has shifted as social and cultural historians have turned to these books to understand popular beliefs. This literature has started to make the case that almanacs were not just critical reflections of popular orthodoxy, but they were also generative sites for integrating and making, what Joan Judge has referred to as the "mundane" revolution.[14] But where does this fit in our models of "old" versus "new"?

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[10] Benjamin Elman summaries this view: "The triumph of modern science in China, as in Europe, required an intellectual transformation that would break the boundaries of textual scholarship, and social, economic, and political changes that would challenge the paramount status of classical studies. Such intellectual and technological transformations began during the seventeenth century in Europe, but they were not fully understood in China until after 1865." Elman, *On Their Own Terms: Science in China 1550-1900*. 279. In addition to the Chinese scholarship cited above, see also Lackner et al., *New Terms for New Ideas*.; Peter Zarrow, *Educating China: Knowledge, Society, and Textbooks in a Modernizing World, 1902-1937* (Cambridge University Press, 2015).

[11] Milne, *Life in China*. 137. For the changing attitudes around almanacs, see Bernard S. Capp, *English Almanacs, 1500-1800: Astrology and the Popular Press* (Cornell University Press, 1979).; Patrick Curry, *Prophecy and Power: Astrology in Early Modern England* (Princeton University Press, 1989).; Maureen Perkins, *Visions of the Future: Almanacs, Time, and Cultural Change, 1775-1870* (Oxford University Press, 1996).

[12] Lister, "Chinese Almanacs"; Parker, "The Chinese Almanac."

[13] Kwok, *Scientism in Chinese Thought*. 67-68; Peter Buck, *American Science and Modern China, 1876-1936* (Cambridge University Press, 1980). 171-208; Zuoyue Wang, "Saving China through Science: The Science Society of China, Scientific Nationalism, and Civil Society in Republican China," *Osiris* 17 (2002): 291–322.; Vincent Goossaert and David Palmer, *The Religious Question in Modern China* (University of Chicago Press, 2011). 52-53; Lei, *Neither Donkey nor Horse*. 102-103

[14] The literature on almanacs and calendars as windows into social life includes Wang, "Time and Change."; Huang Yi-Long, "Tong Shu Zhong Guo Chuan Tong Tian Wen Yu She Hui de Jiao Rong 通書中國傳統天文與社會的交融," *Hanxue Yanjiu* 14, no. 2 (1996): 159–86.; Wu Huifang, *Wan Bao Quan Shu: Ming Qing Shi Qi de Min Jian Sheng Huo Shi Lu 萬寶全書: 明清時期的民間生活實錄* (Guo li zheng zhi da xue li shi xue xi, 2001); Yan 吳岩 Wu, *Qing Dai Li Shu Yan Jiu 清代曆書研究* (Lan mu lan wen hua chu ban she, 2015).; Chen Qiu, "Jin Dai Yi Lai Min Jian Tong Shu Wen Hua Bian Qian Yan Jiu 近代以來民間通書文化變遷研究" (Masters Thesis, Henan da xue, 2018).; Guo Shourong, "Tong Shu: Qing Mo Min Chu Guangzhou Di Qu Min Jian Sheng Huo Zhi Shi de Jian Gou (1900-196) 通書: 清末民初廣州地區民間生活知識的建構 (1900-1916)" (Masters Thesis, National Taiwan Normal University, 2018). For the "mundane revolution", see Joan Judge, *The Politics of Common Reading: Vernacular Knowledge and Everyday Technics in China, 1894–1954* (University of Chicago Press, 2025). 4-5

Chen Tuo has tried to resolve some of these tensions by introducing what he calls the "New Old" Westernizers. Drawing on the history of the book, Chen has contributed several case studies of intermediaries, including Xu Chaojun as a clockmaker, to argue that the rise of new print culture around 1800 brought a new site for circulating technical knowledge.[15] For Chen, figures like Xu Chaojun and Wei Yuan were constrained by older paradigms, both about China's place in the world and the ideas that Western Learning originated from China's own past. This is why they belonged to a late stage of that older moment of exchange. They were "new" in the sense that they were responding to major social and economic change. Following the censorship from the eighteenth century, print culture experienced a new explosion in the nineteenth century that permitted texts which had previously been defined as secretive or state knowledge as public knowledge useful for statecraft. Furthermore, contemporary policy issues in managing relations with different outsiders promoted a new demand for synthesized literature about outsiders and their knowledge. For Chen, these "New Old" figures marked a major intermediary role, but they did not ultimately transcend these divisions between different forms of knowledge.[16]

Nevertheless, I have argued that practitioners focused on practical efforts and drew from disparate sources of knowledge. They saw themselves as participating in an ongoing and updated dialogue. They did not treat these exchanges as being in conflict. The distinction between "Old" and "New" must also be understood as a rhetorical strategy that various late Qing reformers used to justify their own work compared to earlier reform movements. These terms did not always represent major differences in actual practice. For instance, Zeng Guofan and Zhang Zhidong were two of the most important reformers who wrote in favor of "New" Western Learning. They sponsored translations, argued in favor of Western science and technology, and used their position as officials to patronize alternative pathways for learning. Yet in their private lives, they were equally engaged in geomancy and knowing fate.[17] In letters between Zeng Jize and his father, he

[15] Chen Tuo, "Cong Xu Chaojun Dao Xu Jiyu: Jia Dao Shi Qi Xin Jiu Xi Xue de Zhi Shi Mai Luo 從徐朝俊到徐繼畬：嘉道時期新舊西學的知識脈絡," *Jin Dai Shi Yan Jiu*, no. 3 (2023): 122–37; Chen Tuo, "Cong Yang Guangxian Dao Wei Yuan: Qing Dai Wen Hua Bao Shou Zhu Yi de Wen Ben Mai Luo 從楊光先到魏源：清代文化保守主意的文本脈絡," *Qing Shi Yan Jiu*, no. 3 (2023): 77–91.

[16] Chen Tuo, "Cong Xu Chaojun Dao Xu Jiyu: Jia Dao Shi Qi Xin Jiu Xi Xue de Zhi Shi Mai Luo 從徐朝俊到徐繼畬：嘉道時期新舊西學的知識脈絡," *Jin Dai Shi Yan Jiu*, no. 3 (2023): 122–37; Chen Tuo, "Cong Yang Guangxian Dao Wei Yuan: Qing Dai Wen Hua Bao Shou Zhu Yi de Wen Ben Mai Luo 從楊光先到魏源：清代文化保守主意的文本脈絡," *Qing Shi Yan Jiu*, no. 3 (2023): 77–91.

[17] Smith, *Fortune-Tellers and Philosophers*. 148, 186, 188

used milfoil divination to interpret moments of uncertainty.[18] Similarly Yan Fu was a radical reformer involved in some of the most important conversations about changing historical thought. Historians attribute Yan Fu with some of the most significant transformations in applying linear and evolutionary perspectives to Chinese history.[19] Yet Yan Fu maintained multiple journals in his private life. During the tumultuous years at the end of the dynasty, he continued to track fate movements and *Yijing* interpretations alongside his translations of Western science.[20]

This multiplicity, however, can come more into focus when we set aside labels of "tradition" and "modernity" and understand how people sought out tools to manage fate and uncertainty. Almanac makers in South China promoted multiple forms of time measurement simultaneously (chapter 2). On the one hand, almanac makers republished the instructions for how to use the water-clock, and they were some of the individuals who were most influential in sustaining the water-clock of Canton throughout the imperial period. On the other hand, almanac makers throughout the entire nineteenth century published tidal hours and clock times for users. These time units were based on changes in older tidal information that they continued to publish for local shipping. Clock times too were added to almanacs over the course of the century as they started sharing the most important clock hours which could align with ritual times in Guangzhou. The Cai family further illustrates this back and forth. The founder belonged to the Xuehai tang and studied some of the latest translations of new astronomy and mathematics. He was well-read in books on calculus and probably had knowledge about the latest discoveries in astronomy. His own efforts at building almanacs and calendars were meant to be new forms of learning. Yet these publications circulated under the categories of day selection and fortune telling. For practitioners like himself, the standards of astronomical knowledge did not undermine traditional forms of

[18] Smith, *Fortune-Tellers and Philosophers*. 111
[19] Luke S. K. Kwong, "The Rise of the Linear Perspective on History and Time in Late Qing China c. 1860–1911," *Past & Present* 173, no. 1 (2001): 157–90.; Ricardo K. S. Mak, "Yan Fu's Conception of Time and Evolution," in *Notions of Time in Chinese Historical Thinking*, ed. Chun-chieh Huang and John B. Henderson (The Chinese University Press, 2006). 157-174
[20] Smith, *Fortune-Tellers and Philosophers*. 112; Fan Li and Michael Lackner, "Contradictory Forms of Knowledge? Divination and Western Knowledge in Late Qing and Early Republican China," in *Coping with the Future: Theories and Practices of Divination in East Asia*, ed. Michael Lackner (Brill, 2018). 462-463; Michael Lackner, "Forward: Chinese Literati and Intellectuals on Mantic Arts: Philosophy or Divination?," in *Fate and Prognostication in the Chinese Literary Imagination*, ed. Michael Lackner et al. (Brill, 2020). xvii

cosmology, they simply pushed it toward different realms of context, just like other approaches towards contextualizing time.[21]

Clockmaking defies simple categorization as well because clockmakers continued to embrace their association with outside learning and foreign contacts. Chinese clockmakers forged new connections through their practice towards metal, what I have called a "modular" engagement with their artifacts (chapter 4). Clockmakers were mechanics insofar as they cultivated knowledge about managing and controlling things composed with intersecting parts. Yet many clockmakers practiced some form of metal craft and transmitted this knowledge. They were particularly informed about the tonal qualities of metals used for bells. Chinese clockmakers occupied a precarious position in the global supplies of clock parts. While they could make some parts, they more often used their access to foreign exchanges to connect their workshops to these wider circulations of things. In other words, for Chinese clockmakers, metal craft and plastic knowledge were important. They had to cultivate these skills to learn how to fix parts and create copies. But what was even more essential was the knowledge in accessing supplies, what Viktoria Tkaczyk and Christine von Oertzen have termed "supplied knowledge."[22] This was a type of know-how that connected local workshops to global networks of raw materials.

Scholars too were selective in their approach towards updating knowledge. Even though Zhang Zuonan and Qi Yanhuai primarily based their projects on imperial astronomy, they conducted new observations and calculations to update this information for contemporary audiences. They also rejected debates about origins. They evaluated knowledge according to its use. This practical orientation characterized the other people who engaged with their products, whether the gazetteer compilers who incorporated their data, the new cartography projects that tried to fix maps, or the other astronomers who adapted their dials and instruments for their locations. Other scholars outside of these networks also traveled to different sites to selectively appropriate what to incorporate and update. Xu Zongyan, for instance, published notes about the discovery of a new planet based on his conversations with foreign merchants and missionaries in

[21] This story is of course not unique to China. Popular astrology also flourished with the rise of popular astronomy and meteorology. These two sources of knowledge continued to operate through the medium of almanacs into the 1850s. For more work on this change, see Katharine Anderson, "Almanacs and the Profits of Natural Knowledge," in *Culture and Science in the Nineteenth-Century Media*, ed. Louise Henson et al. (Routledge, 2004).; Katharine Anderson, *Predicting the Weather: Victorians and the Science of Meteorology* (University of Chicago Press, 2005). 41-82

[22] Victoria Tkaczyk and Christine von Oertzen, "Introduction: Reconsidering the Resources of Epistemic Tools," *Isis* 114, no. 2 (2023): 359–65.

Guangzhou.[23] The scholar Yao Heng 姚衡 (1801-1850) wrote about meeting John Robert Morrisson and how he saw a new map that changed his perspective.[24] Even Wei Yuan practiced such bricolage as he combined Chinese sources on the West and continued to update his books with some of the newest translations on astronomy from the McCartee almanac (chapter 2).

Material culture places a new emphasis on this heterogeneity. Whether material texts or objects, scholars and artisans incorporated new knowledge under different conditions. They followed a variety of movements and iterations. By bringing material culture to the scholarship on translation and intellectual history, the world of interaction and exchange takes on a larger significance. For this study, I have focused on temporality and the context of astronomy, but this approach can be applied to other fields. For instance, I have not yet included all the incredible ways that time mattered for medicine. Moreover, as medical historians have traced recipes, how might thinking about the physical and raw materials of these procedures impact our view of knowledge exchanges?[25] How might we start to better appreciate the chemical experiments that were conducted in homes and studios?[26] Perhaps materiality will help us better clarify how individual makers participated in communities of practice that tried to connect knowledge to both individual and political goals.

Value of Precision

In addition to the circulation of knowledge, these time instruments also remind us that temporality involved a multitude of different practices for making time legible. There was no clear division between an "abstract" and "concrete" theory of time. The tools that were used for telling time demonstrate that different contexts generated various solutions and priorities. Rather than viewing technologies as determining a particular set of beliefs or actions, technologies were often the spaces for creativity. Throughout my chapters, I have argued that time technologies did not define authority but instead opened spaces for negotiating one's relationship to imperial power. While

[23] Han Qi, "Xu Zongyan Yu 18 Shi Ji Mo Ouzhou Ke Xue Xin Zhi de Chuan Ru 許宗彥與 18 世紀末歐洲科學新知的傳入," *Li Shi Yan Jiu*, no. 1 (2024): 173–87.
[24] Yao Heng, *Han Xiu Cao Tan Bi Ji 寒秀草堂筆記*, Cong Shu Ji Cheng Chu Bian 367 (1887; Shang wu yin shu guan, 1937). j. 3, 96
[25] Lan Li uses peppercorn and its effects to explore how the materiality of numbness produced similar effects and new pathways of knowledge. Lan A. Li, "Numbing Aesthetics: Taste and Tempers of Peppercorn / Mountain Pepper / Sanshō," *Gastronomica* 20, no. 4 (2020): 64–74.
[26] Wright, *Translating Science*. 35-36; Melchior Yvan, *Inside Canton* (Henry Vizetelly, 1858). 184

state calendars *in theory* made political claims about the control over time, *in practice*, that authority depended on many constraining factors.

Calendar infrastructure exemplified these tensions over standardization and individual making. Calendars were ritual tools, and the raw materials used in gathering and producing these objects reflected these theories of social order. Paper, silk, color – these components were a part of temporality. They integrated social infrastructure into temporal infrastructure through raw materials. These choices had lasting impacts as they reinforced political order through the collection and manipulation of things. They extended well beyond the confines of the imperial palace. They were also a part of local sites. Local ecologies fixed calendar production in time and place (chapter 1). Local or "vernacular" print cultures meant that different techniques, including movable-type, woodblock, and stereotype, not only rearranged the appearance of calendars but also the organization in how printers hired and employed laborers. Similar forms of local ecology played out in the gathering of clay or paper effigies to represent the celebration and predictions of the New Year. Regional culture and material culture are useful heuristics to understand locality.[27]

Yet status and identity were malleable, not rigid and fixed. In the case of the calendar ceremony, I introduced some of the cases where imperial princes requested to change these rules. By the eighteenth century, princes of the imperial household and the steppe were able to leverage their positions to argue that they earned new privileges. They requested to use new materials for their calendars. These negotiations resulted in changes that switched the orientation of the rituals and realigned the order of materiality. The materials used in the ceremony illustrated how groups might jockey and advocate for their own representation and self-presentation in the ceremony. Each case required adjustment to align the ritual with previous features creating a more fluid system that was based on doing. Materiality offers the lens to appreciate this process in time. Materiality might therefore provide the mechanism for what Catherine Bell calls "ritualization" or the way of doing the ritual.[28]

This is not simply because different groups imitated and engaged in ritual practices for different situations. For instance, accounts of ritual have emphasized that ritual could be sites of

[27] This is a similar argument to Susan Naquin's new approach to regional culture. She has argued for the integration of regional cultures and material culture through her analysis of a distinct "North China" access to raw materials and local ecologies: brick, clay, stone, woods, and fabric paper. For more see Susan Naquin, "Material Manifestations of Regional Culture," *Journal of Chinese History* 3 (2019): 363–79.; Susan Naquin, *Gods of Mount Tai: Familiarity and the Material Culture of North China, 1000-2000* (Brill, 2022). 4-8

[28] Catherine Bell, *Ritual Theory, Ritual Practice* (Oxford University Press, 1991), 7-8.

resistance, and it could form social solidarity. Even some of the poorest engaged in various levels of ritualization. These two extremes are often treated as opposed. Ritualization mattered for control, and it mattered for resistance.[29] Instead, I am suggesting that we must attend to the materials themselves as a model for exploring when rituals could both create these elements of standardization and differentiation.

Ritual precision offers one rubric to consider how the value of precision came to matter in late imperial and modern China. Ritual precision like ritualization speaks to the process of negotiating and making shared standards (chapter 3). Standardization was not homogeneity. Standardization referred to procedures and the implementation of these procedures to create order. I call this "ritual precision" to capture the different aspects for what these performances were meant to do. Ritual precision referred to the connection between a ritual context and the ritual act. One defined that precision through measurement. Hence, one had to create standard units of measures, divide these into smaller parts, and then use these standards to communicate the ritual to new spaces. Ritual precision like forms, algorithms, and bureaucratic procedures, empowered the control of information. Or in the sense of James C. Scott, ritual precision defined the practice for transforming chaotic systems into legible frames for the state.[30]

The value of ritual precision also contributes to the cultural practices that defined exactitude. It offers a mode for understanding how different cultural values of accuracy and exactness can produce precision and change that definition over time. In the philosophy of science, precision initially captured a specific orientation associated with the late eighteenth century, a new paradigm of scientific research that was predicated on a "mechanical" theory of the universe, predictability, and reproducibility.[31] Because this scientific virtue was treated as a philosophy of the so-called "Baconian" sciences, historians started to examine what conditions allowed this virtue to emerge.[32] Early research demonstrated that this "Quantifying Spirit" was not limited to the exact sciences but spread to other fields including natural history and forestry.[33] In a collected

[29] Smith, "Ritual in Ch'ing China."; Szonyi, "Making Claims about Standardization and Orthopraxy in Late Imperial China"; Sutton, "Cultural Unity, Variation and the State in Ming and Qing Times."
[30] James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (Yale University Press, 1998).
[31] "Du Monde de l'«à-Peu-Près» à l'univers de La Précision." 321, 329
[32] Kuhn, *The Essential Tension*. 219-220; John L. Heilbron, "A Mathematician's Mutiny, with Morals," in *World Changes: Thomas Kuhn and the Nature of Science*, ed. Paul Horwich (MIT Press, 1993). 81-130; Hacking, *The Taming of Chance*. 60-63
[33] Heilbron, "Introductory Essay." 22-23

volume on precision, Norton Wise theorized three criteria that unified precision across domains: control of information, uniformity or mobility, and instrumentation.[34]

Yet subsequent research has demonstrated how contingent these values were. Mary Terrall showed how instrumentation did not necessarily create epistemic closure. In the debates over the shape of the earth, new instruments produced tighter measures that allowed communities to compare expectations to outputs. Yet critics of the new instruments continued to argue that the instruments were flawed, biased, and contained tacit skills, undercutting any attempt at creating consensus through objective measurement. [35] Theodore Porter furthermore argued that quantification and precision were moralizing practices or what he termed "the accounting ideal."[36] Numbers created distance from the self and introduced mechanical forms of judgment. Jimena Canales shows how measurement was increasingly subject to the larger category of personal equations. Stable outputs such as the meter, kilogram, and other standards changed over time, as they were impacted by human and non-human factors. When individuals tried to implement these standards, they did not agree on the actual measured output.[37]

If earlier scholarship had focused on quantification in the sciences, more recent work has expanded the purview by turning towards what practices enabled communities to define repeatability, measurement, and instrumentation. In other words, how was precision defined in specific times and places? This newer approach has recognized practices of precision as extending from antiquity to the present, rather than viewing precision as a scientific virtue associated only with the late eighteenth century. This new goal has then allowed historians to explore how rhetorical practices, instrumentation, and measurement under different societies and cultures built coherent models for the actors themselves by which they could evaluate standards of validity.[38]

My argument for ritual precision therefore contributes a new historical case study for cultures of precision. Ritual precision was a Chinese practice of precision within a larger global conversation on the standards for exactitude. Standardization of the rites aimed to render rites

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[34] Wise, "Introduction." 5-9

[35] Terrall, *The Man Who Flattened the Earth: Maupertuis and the Sciences in the Enlightenment*. 130-172. This is one of the examples for what Harry Collins and Trevor Pinch refer to as the experimenter's regress, i.e. the problem of constructing a valid test when an outcome is still unknown or indeterminate. Harry M. Collins and Trevor Pinch, *The Golem: What You Should Know about Science* (Cambridge University Press, 1998). 97-98

[36] Theodore M. Porter, *Trust in Numbers: The Pursuit of Objectivity in Science and in Public Life* (Princeton University Press, 1995). 50-51

[37] Jimena Canales, *A Tenth of a Second: A History* (University of Chicago Press, 2009). Chapter 2, esp. 37-40

[38] Gluch, "Promises of Precision."

transferrable and mobile. Standardization was not the same as homogeneity. These practices were meant to be repeatable, and they aligned action with context. With the rise of ritual precision, measurements and individual relationships to these practices could be negotiated. Problems of rites had to be defined in smaller units so that individuals could create simultaneous action. To produce the kind of idealized model of coherence in this order, tools of measurement enabled government managers to perform ritual precision.

These local ideals of precision had two important consequences. The first is that when we consider ritual precision as a problem of time and space, ritual precision therefore contributed its own form of synchronization. Synchronization through ritual precision differed in form from longitude problems as it made social coordination explicit while the aspects of time and space became technical problems for governors. Local time and capital time had to be coordinated and synchronized. These actions were controlled by local rituals that generated the times of the calendar. And they belonged to the practices of more intensely shared moments such as eclipses and comets.

Ritual precision also shared its own instruments. Calendars and mathematical tables were forms that allowed the procedures to transfer. Incense clocks and clepsydrae clocks could also be used to measure duration and use this shared unit to make connections and comparisons. As a subset of astronomical attitudes, ritual precision came to encompass mathematical instruments like logarithms, sectors, visualizations, and maps as they generated smaller units of data that allowed for synchronizing local rhythms to state-wide rhythms. Ritual precision might then be interpreted as a template that already provided the path forward for new types of ritualization: national holidays, schools, military.[39]

A second consequence was the emergence of a distinct form of "mechanical" universe. Mechanical clocks did offer models of divided units of time. But they did not presuppose a theory of designer and a theory of control. Already in the Kangxi era, clockwork metaphors reflected values of ritual precision more than theories of absolutism. As the emperor writes, clocks materialized good statecraft. This was not because clocks demonstrated systems of exact probability. Rather it was the fact that clocks broke down. They had to be rewound. Their inner

[39] Harrison, *The Making of the Republican Citizen: Political Ceremonies and Symbols in China, 1911-1929*.; Shao, *Culturing Modernity: The Nantong Model, 1890-1930*.

gears had to be greased. They required a clock repairer to fix them and set them back up.[40] This was a theory of a clockwork universe. But it was not a clockwork universe based on the notion of a clockmaker. It was a theory of the clock repairer.[41] Since ritual precision focused on the creation of smooth order, this was a theory of maintenance and flow.

Market for Time

Finally, my last point is to emphasize that the most significant consequence of these materials for time was that they introduced a market for time. Time was a fundamental component of organizing and sustaining life in late imperial China. It mattered to emperors and farmers. This was something that each person had to know. It could be as simple as the question of what time is it, or it could involve complex computations to determine what qualities mattered for a knowing a particular time. In either case, timeliness informed how one made decisions. There was no single method or tool that dominated, because different contexts required knowing different types of information. Instead, these questions involved an embodied and ecological vision of time. It required awareness to multiple cues and symbols. While some new instruments like clocks combined features into a single instrument, they were not always focused on the functions of time measurement that mattered most to individuals and their families. Even so, people used clocks and other devices to inform them about the time. There was a demand among people interested in purchasing and accessing this information. As the government relaxed its rules on how private merchants could sell and use this time, the state inadvertently promoted a market for time.

I use this phrase "market for time" to refer to its temporal qualities and the commercialization of its instruments. The market for time treated time as an abstract commodity,

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[40] Kangxi 康熙, "Shengzu Ren Huang Di Ting Xun Ge Yan 聖祖仁皇帝庭訓格言," in *Siku Quanshu 四庫全書*, Online Edition, ed. Yun 紀昀 Ji (Di zhi wen hua chu ban you xian gong si, 2004). j. 1, 51b-52a

[41] One of the well-known examples of this reasoning is William Paley, *Natural Theology: Or, Evidences of the Existence and Attributes of the Deity, Collected from the Appearances of Nature* (1809; Sheldon and Company, 1879). 5-6. For general overviews of mechanical philosophy and clockwork, see Silvio E. Bedini, "The Role of Automata in the History of Technology," *Technology and Culture* 5, no. 1 (1964): 24–42.; Otto Mayr, "A Mechanical Symbol for an Authoritarian World," in *The Clockwork Universe: German Clocks and Automata, 1550-1650*, ed. Klaus Maurice and Otto Mayr (Smithsonian Institution Press, 1980).; Otto Mayr, *Authority, Liberty, and Automatic Machinery in Early Modern Europe* (Johns Hopkins University Press, 1986),. 28-101; Dennis Des Chene, *Spirits and Clocks: Machine and Organism in Descartes* (Cornell University Press, 2001).; Alan Gabbey, "What Was 'Mechanical' about 'The Mechanical Philosophy'?," in *The Reception of the Galilean Science of Motion in Seventeenth-Century Europe*, ed. Carla Rita Palmerino and J. M. M. H. Thijssen (Springer Dordrecht, 2004).; Domenico Bertoloni Meli, *Mechanism: A Visual, Lexical, and Conceptual History* (University of Pittsburgh Press, 2019).

but it sold access, more than the commodification of labor time.[42] It focused on the techniques and practices that made time *accessible* and *material*. This market for time led to merchants who specialized in selling time technologies. These merchants sold their expertise in how to interpret time too. This did not mean that labor time was irrelevant. As Andrew Liu argues, tea merchants used incense clocks to increase and optimize production outputs.[43] But these developments were largely parallel to the growth in a commercial market designed to facilitate the access and communication of time. Hence, it was less a market *in* time as it was a market *for* time.

In my view, this market for time was a new phenomenon of the Qing which especially developed in the early nineteenth century and modified the conditions around temporality. Experts in time were not new. For centuries, there had been experts who sold their services. They were fixtures of common life.[44] But the practice of knowing the right time had not always been connected to the broader techniques and technologies of time. These technologies had been monopolized by the government. Yet, the Qing transformed the conditions that enabled this market. This was not simply because the Qing implemented sophisticated efforts to inform people about state orthodoxy. This was, of course, important. It had a direct impact on the scale of time information. That the government promoted this information down to even the village level was a key factor in its growth. But it was also because the barriers to the private practice were progressively relaxed and removed. The Qing granted permission to the sale of instruments and astronomical information. This approval, in turn, allowed instruments to become a commodity. Where time experts had previously focused on the goals of the state, now entrepreneurs could offer

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[42] There were wage-laborers in the Ming-Qing, but they were typically evaluated according to customary measures and day units. Farms hired out both year and day laborers. Urban workers might also compete for positions and wages. For analysis on this see, Philip C. C. Huang, *The Peasant Economy and Social Change in North China* (Stanford University Press, 1985), esp. 155-168.; Philip C. C. Huang, *The Peasant Family and Rural Development in the Yangzi Delta, 1350-1988* (Stanford University Press, 1990), esp. 58-76.; Francesca Bray, *Technology and Gender: Fabrics of Power in Late Imperial China* (University of California Press, 1997), 233-234.; Li, Bozhong 李伯重, *Agricultural Development in Jiangnan, 1620-1850* (St. Martins, 1998), 133-156. Although this question has contributed to different ideas regarding "sprouts of capitalism" in the Ming and Qing, agricultural handbooks did view other units of measurement and value. Tools of duration were used to create measurements of value, such as the incense clock for defining set units of change. Wang Zhen, *Wang Shi Nong Shu* 王氏農書, SKQS (1313), j. 19, 24a-25a. Robert K. Douglas, *China* (D. Lothrop and Company, 1885), 73-75. This raises the critical point that technology mediates both "abstract" and "concrete" time.

[43] Andrew B. Liu, "Incense and Industry: Labour and Capital in the Tea Districts of Huizhou China," *Past & Present* 230 (2016): 161–95.

[44] Christian de Pee, *The Writing of Weddings in Middle-Period China: Text and Ritual Practice in the Eighth through Fourteenth Centuries* (State University of New York Press, 2012), 137-178.; Yang, "Like Stars in the Sky"; Yang, "Lesser Elite in Crisis: Family Strategies of Divination (Yinyang) School Instructors in the Yuan–Ming Transition."

tools to meet different types of needs and goals. These efforts introduced a new kind of dynamic to the practices of time.[45] This market for time linked to the other circuits of market towns and commercialization of the Chinese village and community.[46]

The market for time allowed for choice. More than just a proliferation of tools, the market for time permitted private, subjective visions of time. For almanac makers and clockmakers, it gave them permission to target designs for more specific situations. They were able to focus on niche audiences. For consumers, the market for time gave them choices. For some, those choices meant identity. For others, those choices reflected efficiency. For others, those choices meant duty. This was a shift in the meaning and application for time, and it laid the groundwork for implementing new ideas about time into larger scales and contexts.

One of the most important outcomes of commercialization in time information was the innovation in the techniques and technologies used to access these materials. In chapter 2, I discussed almanac makers and their approaches to creating graphic structures to explain time. These graphic devices formed the interfaces of new frames and layouts. These layouts increased the searchability for identifying information about auspiciousness. These types of search techniques used indexes to create shared units for identifying a unit of time. As a part of this innovation in treating pages as an interface to consume time information, almanac makers tried to construct pages that communicated all the necessary information in a tighter arrangement with graphical elements of bold, highlights, and even color. These features became units for structuring time information and folding that information into discrete graphical chunks. These same

[45] Richard Smith has suggested that the Qing period marked an increase in divinatory practices even though the seventeenth century gave rise to a variety of critical voices against more esoteric practices. Richard J. Smith, "'Knowing Fate': Divination in Late Imperial China," *Journal of Chinese Studies* 3, no. 2 (1986): 161. Nevertheless scholars of late imperial mantic practices have remained preoccupied with the idea that these markets depended on texts and government censorship. Most historians, with the exception of Lü, have not paid attention to the shifting legal regulations about the private study of astronomy. And even if they do recognize that there were important changes in these restrictions, little research has emphasized that this had an impact on material culture just as much as the world of publishing. Huang Yi-Long, "Tong Shu Zhong Guo Chuan Tong Tian Wen Yu She Hui de Jiao Rong 通書中國傳統天文與社會的交融," *Hanxue Yanjiu* 14, no. 2 (1996): 159–86.; Yoke, *Chinese Mathematical Astrology*.; Xiaoyuan Jiang, *Chinese Astrology and Astronomy: An Outside History*, trans. Wenan Chen (World Scientific, 2020).; Lingfeng Lü, "Divination and Its Institutionalization in Pre-Modern China," in *Handbook of Divination and Prognostication in China: Part One Introduction to the Field*, ed. Michael Lackner and Zhao Lu (Brill, 2022), 298.

[46] G. William Skinner, "Marketing and Social Structure in Rural China: Part I," *The Journal of Asian Studies* 24, no. 1 (1964): 1–43; G. William Skinner, "Marketing and Social Structure in Rural China: Part II," *The Journal of Asian Studies* 24, no. 2 (1965): 195–228; G. William Skinner, "Marketing and Social Structure in Rural China: Part III," *The Journal of Asian Studies* 24, no. 3 (1965): 363–99.

techniques became the informational strategies that structured the layouts of other popular reading media.[47]

Commercialization impacted more than paper media, for it resulted in distinct objects and instruments that were designed to appeal to popular markets of gentry, merchants, and others. Almanac makers could sell time instruments with their almanacs. They might sell incense sticks that were meant to be calibrated for more precise measurements. Popular media were also relevant for the clockmakers and their new clocks. Xu Chaojun and Qi Yanhuai used their knowledge of time to construct instruments that were sold to create fate. Xu popularized his own inventions. These designs offered instruments that gentlemen could manipulate and access to understand astrological information from their own home. Qi Yanhuai similarly envisioned his mechanical clocks as models for fate calculation. These tools were supposed to make it possible for any person to be able to figure out how to calculate birth and astrological time. While clockmakers were able to interact with elites, they were also more aware of the marketed nature of their products. The biographies of other clockmakers indicate that they continued to design different types of products based on mechanical clockwork, and they used this material to appeal to niche markets.[48]

Just as this market for time promoted wider access to theories and information on time, statecraft reformers participated in this market as a new opportunity to change attitudes about government and management. In chapter 3, I detailed the case of Zhang Zuonan. Zhang Zuonan was a pioneer in connecting statecraft reform to scholar-gentry. He used his books and teaching to educate audiences about mathematics and astronomy. These writings were meant to serve as tools of improvement. As educated readers outside of the bureaucracy started to understand the common values that formed the basics of a learned or gentlemanly education, they came to appreciate the significance of mathematics for management. This required detailed uses of precision that would then align local times with state times. This vision of ritual and precision governance formed a theory that local government was not just the responsibility of bureaucrats. It reframed responsibility towards the educated and the learned. Scholars helped in management. With the

[47] Rusk, "Writer's Block or Printer's Block." Although Barbara Mittler views the modernization of visual techniques as a process of adaptation to local context, she attributes more of this process as operating via Japan in the context of newspaper layouts. Barbara Mittler, *A Newspaper for China?: Power, Identity, and Change in Shanghai's News Media, 1872–1912* (Brill, 2004), 47-53.

[48] For example, Liu Dakui and Zhang Peifang, eds., *She Xian Zhi 歙縣志* (1771). j. 15, 147a-147b; *She Xian Zhi (Minguo) 歙縣志（民國）*, ZGFZK (1937). j. 10, 1719; *Xuancheng Xian Zhi (Jiaqing) 宣城縣志（嘉慶）*, ZGFZK (1808). j. 22, 1609

proper tools, they were supposed to be equipped with the learning and education that would enable them to lead in their communities.

The market for time can be linked to the growth in practical knowledge. The tools and instruments were practical solutions. These instruments formed a subset of print books designed to communicate useful knowledge. These books included encyclopedias and almanacs, as well as other forms of how-to literature. This genre grew in significance. There were new compilations of medical recipes and household management. There were even embroidery handbooks, painting manuals, and commercial guides.[49] Andrew Schonebaum argues that the impact was felt beyond the confines of genres. Although genres mattered, fiction and entertainment were not necessarily treated as outside informational media. Readers combined different sources of entertainment and wonder to refine their view of the world.[50]

Practical knowledge contributed to material culture as well. It was not just about books. It included all sorts of new objects. This history included useful things, like umbrellas, rickshaws, spectacles, matches, kerosene, and more.[51] While the demand for new things had a close relationship to treaty ports, this was not the only space exercising its influence. There were internal markets that also expanded access to useful goods. Historians have noted how local entrepreneurs generated other applications of useful things, such as the innovators in profit-motivated agricultural and the circulation of seeds or the medicine men who sold patent medicines.[52]

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[49] Lufrano, *Honorable Merchants*.; Lisa R. Claypool, "Figuring the Body: Painting Manuals in Late Imperial China" (Phd Dissertation, Stanford University, 2001).; Grace S. Fong, "Female Hands: Embroidery as a Knowledge Field in Women's Everyday Life in Late Imperial and Early Republican China," *Late Imperial China* 25, no. 1 (2004): 1–58.; J. P. Park, *Art by the Book: Painting Manuals and the Leisure Life in Late Ming China* (University of Washington Press, 2012). After educational works, how-to literature was probably the most important category for everyday readers. Brokaw, *Commerce in Culture*. Chapter 11

[50] Andrew Schonebaum, *Observing the Unseen: Curiosity and Common Knowledge in Early Modern China* (University of Washington Press, 2026). 1-20

[51] Susan Mann, "Women's Work in the Ningbo Area, 1900-1936," in *Chinese History in Economic Perspective*, ed. Thomas G. Rawski and Lillian M. Li (University of California Press, 1992).; Chi Ming Fung, *Reluctant Heroes: Rickshaw Pullers in Hong Kong and Canton, 1874-1954* (Hong Kong University Press, 2005).; Dikötter, *Things Modern: Material Culture and Everyday Life in China*.; Kazuko Furuta et al., eds., "Playing with 'Alien Fire' (Yanghuo): Matches in Late Nineteenth-and Early Twentieth-Century China," in *Imitation, Counterfeiting and the Quality of Goods in Modern Asian History* (Springer Singapore, 2017).; Lean, *Vernacular Industrialism in China*. Spectacles are particularly interesting as they shared both local and global trends. For additional information on the varieties of lens types, see Otto Durham Rasmussen, *Old Chinese Spectacles* (North China Press, 1915), 12-13; Otto Durham Rasmussen, *Chinese Eyesight and Spectacles* (Tonbridge Free Press, 1949), 27-41; Chiu Chung-lin, "Cong Ming Mu Dao Shang Zhan - Ming Dai Yi Jiang Yan Jing de Wu Zhi Wen Hua Shi 從明目到商戰——明代以降眼鏡的物質文化史," *Zhongyang Yanjiuyuan Lishi Yuyan Yanjiusuo Jikan* 90, no. 3 (2019): 480-483.

[52] Sherman Cochran, *Chinese Medicine Men: Consumer Culture in China and Southeast Asia* (Harvard University Press, 2006).; Peter B. Lavelle, *The Profits of Nature: Colonial Development and the Quest for Resources in*

In sum, to think about the market for time is to understand how popular culture and the demand for useful knowledge and things inspired social and cultural change. These changes had elements that were related to external influences. When we talk about clocks and pocket-watches, we are also discussing the role of foreigners and eventually the specific cases of treaty ports in changing social and economic life of imperial China.[53] But this is not the whole story. Other actors were also using these objects and materials to achieve their goals. There were creative solutions that did not always align with the original intentions or plans. Designs transformed with new engagements and creators. The market for time created a space for imagination and creativity. And it is the market that helped create an even more dynamic material infrastructure for time in imperial China.

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In fall 2025, the National Security Agency allegedly engaged in a cyber-attack against the Chinese Time Service. The National Time Center is a part of the Chinese Academy Sciences and rests in the heart of central China in Xi'an. The center contains some of the most sophisticated atomic clocks in the world today. These clocks have become the master clocks that control Beijing time. The clocks regulate BeiDou 北斗, or the Chinese version of GPS. The attacks ultimately failed. The Chinese Time Service was able to remove the atomic clocks from the network, patch the security breaches, and then place the clocks back online. Yet the attack echoes a central thesis of my dissertation: the material infrastructures of time matter.[54]

The materials for making time have been important tools for organizing society and managing everyday life. These tools can have rules for how they are supposed to be used, and they

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Nineteenth-Century China (Columbia University Press, 2020).; Peter B. Lavelle, "Placing the Science of Agriculture in Early Twentieth-Century China," *Isis* 113, no. 4 (2022): 816–28.

[53] Paul Cohen refers to this effect as the relationship between the littoral and the hinterland. Cohen, *Between Tradition and Modernity*. 242-243

[54] Li Benyang et al., "Xian Hou Hou Yong 43 Ruan Te Zhong Wu Qi 'Beijing Shi Jian' Cao Meiguo Wang Gong Geng Duo Xi Jie Bao Guang 先后启用 42 款特种武器 '北京时间'遭美国网攻更多细节曝光," *Qi Yi Ke Hu Duan*, October 19, 2025, https://m.12371.gov.cn/content/2025-10/19/content_500765.html; Liz Lee, "China Accuses US of Cyber Breaches at National Time Centre," *Reuters*, October 20, 2025, https://www.reuters.com/world/china/china-accuses-us-cyber-breaches-national-time-centre-2025-10-19/. For additional context on GPS and China's information architecture, see Evan A. Feigenbaum, *China's Techno-Warriors: National Security and Strategic Competition from the Nuclear Age to the Information Age* (Stanford University Press, 2003); William Rankin, *After the Map: Cartography, Navigation, and the Transformation of Territory in the Twentieth Century* (University of Chicago Press, 2016); Rumi Aoyama, "China's Dichotomous BeiDou Strategy: Led by the Party for National Deployment, Driven by the Market for Global Reach," *Journal of Contemporary East Asia Studies* 11 (2022): 282–99.

can lead to unexpected challenges and outcomes. These materials transformed late imperial China. Some technologies reflected earlier beliefs, whereas others offered new possibilities. Time tools and their techniques were interconnected artifacts. They helped create an interface for organization and planning for the future. Today, we use mobile phones rather than sundials. But careful attention to the historical circumstances that produced these infrastructures remains necessary. These historical models can help us better understand how these networks have come to exert such power over our lives and better appreciate the global dimension of these networks.

Appendices

Appendix A: Case of Mongolia

Mongolia provides an important case study for exploring Qing calendar infrastructure. It both adumbrates and challenges how the state and society negotiated calendars. The calendar in Mongolia was not a marginal affair. The empire devoted extensive resources to the publishing of calendars in Mongolian. While the scholar Wang Yuanchong has suggested that Mongolian-language calendars were irrelevant to Mongolian time contexts and simply reflected Qing state symbols, Johan Elverskog and Brian G. Baumann have argued that the Qing calendar formed a distinct feature of "imperial time".[1] According to one interpretation, the Manchus and the Mongols formed a joint aristocratic state over the Chinese bureaucracy.[2] This extended to time. Yet what exactly that entailed is difficult to pinpoint. Were calendars another tool of social control? The answer is complicated. Even as state calendars became an important source of interaction and negotiation with the Qing state, Mongolian leaders continued to redesign the meaning of state calendars. State calendars occupied an unusual status as both reference points for calendaring and artifacts of local ritual. Calendars frequently arrived late in Mongolia. Much later than other parts of the Qing empire. Yet local leaders integrated state calendars into the rituals of local power. State calendars therefore became important artifacts in the practice of rulership in the steppe.

A.1 Multiple Temporal Practices

That calendars could share these two functions reflected some of the ways that Mongols had negotiated their relationships to different types of calendars over time. Several types of calendars circulated among the Mongols, and they were used for different purposes. One of the most well-known was the animal cycle, which had earlier origins in attaching a fixed order of animals to each

[1] Wang, "Qing Dai Shi Xian Shu Yu Zhongguo Xian Dai Tong Yi Duo Min Zu Guo Jia de Xing Cheng"; Elverskog, "Mongol Time Enters a Qing World"; Baumann, "Divine Knowledge."
[2] Lhamsuren Munkh-Erdene, *The Taiji Government and the Rise of the Warrior State: The Formation of the Qing Imperial Constitution* (Brill, 2022).

month. This calendar had its origins to Turkish calendars.[3] The calendar could be used in the official translations used to organize and match the months with Chinese months.[4] The Mongols also used their own names for months.[5] These terms were related to animals as well, but these were not the same animals used in the Turkish animal cycle.[6] The terms may have related to herding and pastoral activities conducted during different seasons.

The evidence from different calendars shows that the names were not always used consistently. For instance, scholars have debated how different Mongol groups calculated the first month of the year and when to place this calendar in relation to the dates of the solar calendar.[7] Following reforms made during the Yuan period, the Kalacakra or Tibetan Buddhist calendar also served as a system of reckoning time.[8] The calendar became increasingly significant for Mongols from the sixteenth century onwards although all of these various calendars continued to have various components that functioned for various aspects of life.[9]

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[3] For more on this topic see, Louis Bazin, *Les Systemes Chronologiques Dans Le Monde Turc Ancien* (Editions du CNRS, 1991), 385-412.; Louis Bazin, "Les Noms Turcs et Mongols de La Constellation Des 'Pleiades,'" *Acta Orientalia Academiae Scientiarum Hungaricae* 10, no. 3 (1960): 295–97.; Alexander Vovin, "Some Thoughts on the Origins of the Old Turkic 12-Year Animal Cycle," *Central Asiatic Journal* 48, no. 1 (2004): 118–32.

[4] Herbert Franke, *Mittelmongolische Kalenderfragmente Aus Turfan* (Verlag der Bayerischen Akademie der Wissenschaften, 1964), 34.; Ho, "The Political Power and the Mongolian Translation of the Chinese Calendar During the Yuan Dynasty."

[5] Lu Ciyun, *Yi Shi Ji Yu 譯史紀餘*, Cong Shu Ji Cheng Xin Bian 97 (1899), j. 4, 640.; Gyorgy Kara, "Zhiyuan Yiyu Index Alphabetique Des Mots Mongols," *Acta Orientalia Academiae Scientiarum Hungaricae* 44, no. 3 (1990), 279-344.

[6] Antoine Mostaert, *Textes Oraux Ordos, Recueillis et Publiés Avec Introduction, Notes Morphologiques, Commentaires et Glossaire* (Cura Universitatis catholicae Pekini edita, 1937), 131-132.; Louis Bazin, *Les Systemes Chronologiques Dans Le Monde Turc Ancien* (Editions du CNRS, 1991), 391-398 ; Volker Rybatzki, "Names of the Months in Middle Mongol," in *Altaica Budapestinensia Mmii: Proceedings of the 45th Permanent International Altaistic Conference (PIAC) Budapest Hungary, June 23-28, 2002*, ed. Alice Sarkozi and Atilla Rakos (Hungarian Academy of Sciences, 2002), 263-266.

[7] Francis Woodman Cleaves, "The Sino-Mongolian Inscription of 1362 in Memory of Prince Hindu," *Harvard Journal of Asiatic Studies* 12, no. 1/2 (1949): 116-117.; Ts. Chagdarsuren, "La Signification d'une Etude Sur Antoine Mostaert," in *Antoine Mostaert (1881-1971): C.I.C.M Missionary and Scholar*, ed. Klaus Sagaster (Ferdinand Verbiest Foundation, 1999), 47-49.; Volker Rybatzki, "Names of the Months in Middle Mongol," in *Altaica Budapestinensia Mmii: Proceedings of the 45th Permanent International Altaistic Conference (PIAC) Budapest Hungary, June 23-28, 2002*, ed. Alice Sarkozi and Atilla Rakos (Hungarian Academy of Sciences, 2002), 262; Brian G. Baumann, "Divine Knowledge: Buddhist Mathematics According to Mostaert's Manual of Mongolian Astrology and Divination" (Phd Dissertation, Indiana University, 2005), 282-287

[8] Dieter Schuh, *Untersuchungen Zur Geschichte Der Tibetischen Kalenderrechnung* (F. Steiner, 1973), 6-7.; Dieter Schuh, Untersuchungen zur Geschichte der tibetischen Kalenderrechnung, 6-7; Ho Kai-Lung, "Yuan Chao Di Shi Cang Wen Fa Zhi Yu 'Shou Shi Li': Lun Cang Li Yu Han Li Zhi Qu She 元朝帝師藏文法旨與'授時歷'：論藏曆與漢曆之取捨," *Yuan Shi Ji Min Zu Yu Bian Jiang Yan Jiu Ji Kan* 25, no. 1 (2013): 139–50.

[9] Johan Elverskog, "Mongol Time Enters a Qing World," in *Time, Temporality, and Imperial Transition: East Asia from Ming to Qing*, 1st ed., ed. Lynn A. Struve, Asian Interactions and Comparisons ; 8 (University of Hawaii Press, 2005), 162-166.

How then did the Qing relate their imperial calendar to a space of multiple calendars? Initially, the Qing distinguished between different groups of Mongols and therefore treated calendar use as a bond with the emperor. They did not impose standardization and integration into the technical system for all groups. The Qing printed Mongolian calendars for princesses and other Mongol princes in Beijing, and they required the Inner Mongols who had developed alliances with the Manchu leaders to accept imperial calendars.[10] Most Khalkha Mongols remained independent of the calendar system in the seventeenth century. However, in the eighteenth century, the Qing expanded into Central Asia. They also had conflicts with the Junghars. As a result, the Manchus commissioned maps and detailed measurements of the Mongol territory. This not only meant that the calendars themselves started to incorporate more detailed material about Mongol-speaking areas, but it also meant that as the Mongols were organized into territorial units of banners, these boundaries became structures for receiving calendars.[11]

Nevertheless, even when the Qing started to shift official policy in the eighteenth century, Mongols engaged with these calendars in a variety of different ways. Some Mongols did integrate their history within a Tibetan Buddhist narrative that was sponsored by the state. But other Mongol groups continued to practice both the newer Tibetan Buddhist calendar methods and the older Uighur methods, neither of which aligned with the imperial calendar system.[12]

Although in everyday life Mongols could relied on environmental cues to determine activities of herding and mobility, many other factors shaped how Mongols viewed and constructed time. Mongols, just like their Chinese neighbors, relied heavily on a variety of practices for predicting the future and forming confidence for the proper time to act. Within this world, Qing imperial calendars therefore gained important status in everyday life through the assimilation of state divination within the diffused world of folk practices. The Yuan empire actively promoted such practices adapted to Mongols, and these practices continued. Even after

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[10] Xiaochun and Chunhua, "Qing Ting Ban Fa Meng Gu Wen 'Shi Xian Shu' Shi Mo 清廷頒發蒙古文'時憲書'始末," *Gu Gong Bo Wu Yuan Yuan Kan* 218, no. 6 (2020): 103, 105

[11] Xiaochun and Chunhua, "Qing Ting Ban Fa Meng Gu Wen 'Shi Xian Shu' Shi Mo 清廷頒發蒙古文'時憲書'始末," *Gu Gong Bo Wu Yuan Yuan Kan* 218, no. 6 (2020): 106. For more on territory and banner affiliation, see Dorothea Heuschert-Laage, "Globalisation or Isolation: Regulating Mobility of Mongols during the Qing Period (1636-1911)," in *Mongolian Responses to Globalisation Processes*, ed. Ines Stolpe et al. (EBVerlag, 2017), 21-37.; Johan Elverskog, *Our Great Qing: The Mongols, Buddhism, and the State in Late Imperial China* (University of Hawai'i Press, 2006), 127-165.

[12] Johan Elverskog, "Mongol Time Enters a Qing World," in *Time, Temporality, and Imperial Transition: East Asia from Ming to Qing*, 1st ed., ed. Lynn A. Struve, Asian Interactions and Comparisons ; 8 (University of Hawaii Press, 2005), 165-170

the decline of printing, Mongols practiced many forms of these divination practices within their manuscript tradition.[13] These traditions circulated well into and throughout the Qing period. For instance, in a study of nineteenth-century Mongolian language divination manuscripts, Ondrej Srba has shown that popular beliefs continued to view certain practices as indebted to Chinese origins. Although Tibetan language texts had their own schools of divination, Mongolian language works remained eclectic in how they explained divination practices and their contexts. Accordingly, these works frequently attributed the transmission of geomancy and day selection techniques which were used in the everyday needs of burial and marriage to folk narratives of Chinese *yinyang* practitioners and even histories of historical Chinese emperors.[14]

The practice of consulting proper directions and times for building and travel also came to have significance even though these actions were now interpreted primarily through Buddhist specialists rather than *yinyang* specialists. For instance, in 1879, a set of local leaders wished to establish a new monastery. But to lay the proper foundation stone, the monastics had to return to Urga and hire geomantic specialists. These specialists determined which physical shapes were the most important as well as which times of the year were the most auspicious for the beginning of the construction.[15] Similarly, mobile monasteries in Western Mongolia relied on day selection techniques to determine the time for transhumance. The community had summer and winter land for their herds. They did not move just according to seasonal triggers but through the determination of the auspicious time to travel. Pozdneev explained, "First of all, the dzurkhaichis or astrologers determine the time for the transhumance and fix the auspicious days both for leaving the spot and for building, or as Mongolian says literally, 'descending' the khuree [monastery and its herds] in the new spot. For the khuree to wander through and cross a distance of 40 or 50 versts, the lamas sometimes need 4 and 5, and sometimes even 8 or 10 days to fix the auspicious days…At each stop to spend the night, the lamas perform a special prayer service to the gajar-un ejen i.e. the guardian spirit of that locality where they spent the night. On arriving on the new spot, the lamas, before unloading the animals, begin to conduct the set prayer service to the gajar-un ejen and only

[13] Ho Kai-Lung, "Spread and Preservation of Chinese Divination in Mongolian, 14th–17th Centuries: The Documents of Dunhuang, Turfan, Qara Qota and Xarbuxyn Balgas," *Central Asiatic Journal* 56 (2013 2012): 142-146.; Elisabetta Chiodo, ed., *The Mongolian Manuscripts on Birch Bark from Xarbuxyn Balgas in the Collection of the Mongolian Academy of Sciences*, vol. 1 (Harrassowitz, 2000), 208-209.

[14] Ondřej Srba, "Frame Narratives Concerning the Chinese Origin of Divination and Geomancy in Mongolian Manuscript Texts," *Acta Orientalia Academiae Scientiarum Hungaricae* 74, no. 3 (2021): 436.

[15] Alekseĭ Matveevich Pozdneev, *Religion and Ritual in Society: Lamaist Buddhism in Late 19th-Century Mongolia*, trans. John R. Krueger (The Mongolia Society, 1978), 49-53.

then do they begin to set up the khuree and all belonging to it in its place. After that their old life begins, common to every time and place."[16]

A.2 Mongolian Shixian shu

While this description may sound as though Tibetan practices remained particularly strong, state calendars, in fact, became a subtle technology of standardization that helped maintain continuity and structure, even to the alternative calendars in place. The administration made this clear in several ways. According to the regulations for the Lifanyuan, the office included the highest-ranking offices of Tibetan Buddhism in Beijing among the distributions. However, unlike most of the garrisons, these offices received Manchu editions of the state ephemerides as well as Mongolian-language calendars.[17] In other words, while the state recognized that these institutions helped manage and publish the Tibetan calendars which had slightly different forms of reckoning, they still used official sources to construct the fixed positions of celestial bodies that had to be employed in the application of calendar methods. Moreover, the institutions were based in the heartland of the Qing calendar and hence had to engage in calendar shifting as a daily practice in the capital. They were reliant on state astrological calendars for making equivalences across different calendar systems.[18] This also matches with the strategy that emerged in the late Qianlong period to produce more Mongolian and Manchu-language translations of imperially sanctioned astrology works, such as the Jade Casket Manual. The department also devoted resources to producing additional textbooks in Mongolian. These books were associated with some of these centers of higher learning in Beijing and Hohhot.[19]

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[16] Alekseĭ Matveevich Pozdneev, *Religion and Ritual in Society: Lamaist Buddhism in Late 19th-Century Mongolia*, trans. John R. Krueger (The Mongolia Society, 1978), 166.

[17] Rongzheng 張榮錚 Zhang, ed., *Qin Ding Li Fan Bu Ze Li 欽定理藩部則例* (Tianjin gu ji chu ban she, 1998), j. 23, 4b.

[18] Kevin Birth describes this process as a type of "calendrical uncanniness" and "polyrhythm". While the Gregorian calendar initially did connect to religious identity, as the calendar became more secularized, the calendar served as a tool for coordination and organization through imperial hierarchies. Kevin Birth, *Objects of Time: How Things Shape Temporality* (Palgrave Macmillan, 2012), 91-96, 100-106. There is a similar type of process operating between religious calendars of Buddhism and the institutional context of the Qing timekeeping network, where two distinct rhythms existed in connection to one another, and by nature of the asymmetry of power one had to constantly adjust and move toward it, creating another type of polyrhythm.

[19] Relevant texts include Laufer 281 and Laufer 286 from Krueger, "Catalogue of the Laufer Mongolian Collections in Chicago." Also "Ioi Hiya Gi," n.d., Mandchou 218, Bibliotheque Nationale de France, Département des Manuscrits; "Ioi Hia Gi Bithe," n.d., Mandchou 219, Bibliotheque Nationale de France, Département des Manuscrits.; Sideng, ed., *Tian Wen Yuan Li: Menggu Wen 天文原理: 蒙古文*, 3 vols. (Nei Menggu wen hua chu ban she, 2022). For more context on the technical aspect of these exchanges, Jo, "Topics on the History of Tibetan

These were not just priorities for institutions located near the center. But the shift in institutional control over these fundamental units can also be viewed in the frontier. The local government archives in Mongolia demonstrate that the government distributed imperial calendars within the Buddhist hierarchy in Urga too. In Jiaqing 15, for example, the calendars arrived in the twelfth month. The amban governor distributed the calendars to the nobles per the official regulations. Among the various receipts from nobles is one from [Lobsangrkügcüg].[20] He was a lama posted as the šanjodba for the Jebstundampa's šabinar. He responded saying that the office had received their calendar for the next year.[21] Similarly, in Daoguang 14, Gombujab, another šanjodba for the Jebstundampa, along with several other ranked officials, sent a reply to the governor, notifying him that "this year on the twenty-eighth day of the twelfth month, we received one volume of the calendar in Mongolian script sent from your office."[22]

These were special positions that connected civil and church hierarchies.[23] The šanjodba belongs to the category of positions which Robert Miller has termed the "Manchu hierarchy" as opposed to the "Tibetan" organization which had emerged out of that tradition.[24] This is to say that these monastic positions were introduced during the Qing period, and they were the primary entry point for connecting the civil bureaucracy to the religious hierarchies. The šanjodba were primarily financial administrators, and they were only present in the monasteries which were attached to private holdings of land and people, the šabinar.[25] Although the šanjodba was a trained lama, he did not necessarily take the most restrictive vows, and he maintained communication and contact with the outside world.[26] This relationship is significant. These types of monasteries with large

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Astronomy."; Leonard W. J. van der Kuijp, "From Chongzhen lishu 崇禎曆書 to Tengri-yin udq-a and Rgya rtsis chen mo," in *Tibetan Printing: Comparisons, Continuities, and Change*, ed. Hildegard Diemberger et al. (Brill, 2016). For more on Mongols and astronomy, see Dondogzhalyn Mönkh-Ochir, *Mongol Zurkhaĭn Tüükh Монгол Зурхайн Түүх* (Interpress Khėvlėliĭn Kompani, 2000), 83-94; Borjigin Vangcuġ, *Monggolcud-Un Odun Orun Jiruqai-Yin Uqaġan-u Teuke* (Liyuuning-un Ündüsüten-ü Keblel-ün Qoriy-a, 2008), 607-822.

[20] The handwriting is difficult with this name. The spelling could be different.

[21] NAM, M-1, Folder 1, File 3507, Document 49

[22] NAM, M-1, Folder 1, File 3993, Document 52

[23] H. S. Brunnert and V. V. Hagelstrom, *Present Day Political Organization of China* (Paragon, 1911), 448-449.

[24] Robert James Miller, *Monasteries and Culture Change in Inner Mongolia* (O. Harrassowitz, 1959), 54-55.; David M. Farquhar, "The Ch'ing Administration of Mongolia up to the Nineteenth Century" (Phd Dissertation, Harvard University, 1960), 221-222.

[25] For additional context on the management of populations under these categories, see Sam Bass, "Slave Donations to Buddhist Parishes in Qing Mongolia," *Harvard Journal of Asiatic Studies* 81, no. 1/2 (2021): 109–31.; Sam Bass, "The Bound Steppe: Slavery, State, and Family in Qing Mongolia" (Phd Dissertation, Indiana University, 2021).

[26] Robert James Miller, *Monasteries and Culture Change in Inner Mongolia* (O. Harrassowitz, 1959), 54-55.; David M. Farquhar, "The Ch'ing Administration of Mongolia up to the Nineteenth Century" (Phd Dissertation, Harvard University, 1960), 221-222.

endowments were among the places where there were colleges for specialized studies in the various sciences including astronomical studies.[27] In other words, through these figures, imperial calendars also had the chance to circulate and become resources for the training and organization of specialized knowledge.

A.3 Calendars and Seals

Imperial calendars also impacted these relationships because they were important structuring principles in the management of local authority. Seals were the most visible aspect of state authority in local society. And for many Mongols, they were viewed as sacred objects in themselves.[28] Furthermore, the act of receiving a seal that was connected to the state government offered a vehicle for granting authority to local leaders. Drawing on examples of seal bestowal and recognition, Elverskog has argued that the Qing adopted these Mongol traditions to legitimize authority in local society by transplanting sacred leadership from the Chinggisid lineage to the Manchu emperors. The granting of the seal was explained through the language of sacred rituals related to Chinghis Khan, except the Manchu emperor was treated as the source of spiritual authority through Buddhism. Seals granted autonomy to individual bannermen and leaders in their communities, but they also depended on the relationship established between these elites and the emperor.[29]

The distribution of the state calendar formed an integral part in the communication of this system within everyday life. For instance, seal closing and seal opening were also practiced in central China, because the state seal was viewed as a visible marker of the state authority in local society here as well. In Central China, these moments in time marked the beginning of the New

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[27] Alekseĭ Matveevich Pozdneev, *Religion and Ritual in Society: Lamaist Buddhism in Late 19th-Century Mongolia*, trans. John R. Krueger (The Mongolia Society, 1978), 48; Robert James Miller, *Monasteries and Culture Change in Inner Mongolia* (O. Harrassowitz, 1959), 49-50.; David M. Farquhar, "The Ch'ing Administration of Mongolia up to the Nineteenth Century" (Phd Dissertation, Harvard University, 1960), 215.

[28] Antoine Mostaert, "Materiaux Ethnographiques Relatifs Aux Mongols Ordos," *Central Asiatic Journal* 2, no. 4 (1956): 253. The sacred view of imperial seals had parallels in Chinese local society as well. Secret societies also used seals as symbols of authority and connected these objects as transmissions given by the emperor. Taoist ritual also used seals as a symbol of authority. As a part of a ritual meeting the spirits, the Taoist priest had to create a special seal which connected the individual with the Emperor of Heaven and transmitted this authority to the priest by which he then could use the woodblock seal to block and protect certain artifacts. For more on these contexts, see Jean DeBernardi, *Rites of Belonging: Memory, Modernity, and Identity in a Malaysian Chinese Community* (Stanford University Press, 2004), 85.; Michael R. Saso, *The Teachings of Taoist Master Chuang* (Yale University Press, 1977), 140-142.

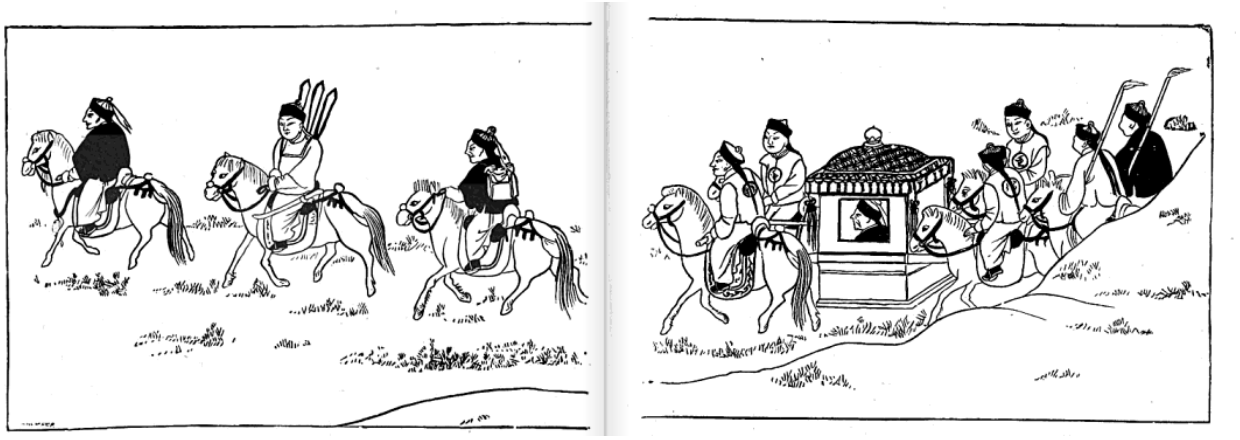
[29] Johan Elverskog, *Our Great Qing: The Mongols, Buddhism, and the State in Late Imperial China* (University of Hawai'i Press, 2006), 82-85.

Year vacation, but they were also among the rituals conducted by specialists rather than by the government official himself. During the closing ceremony, officials prepared by first stamping many blank documents (in case they had to use documents during the period when the seal was already locked away). Then the highest officials locked up their seals followed by subordinates. On the appropriate day and at the appropriate hour of closing, the yamen official commenced the ceremony by placing the seal on the tribunal table. He wore official robes and followed the directions of the master of ceremonies. He kneeled in front of the seal and bowed before it nine times, and then the master of ceremonies or another clerk raised the seal and spoke words of affirmation. He placed the seal in a special box which was shut and locked with two pieces of red paper on the outside to mark it as closed. The box was then covered in imperial silk and locked in the treasury room until the time for the opening ceremony. All the lower ranks followed the ritual and locked up their seals in the same process.[30] At the appropriate time near the end of the first month, the ritual was done in reverse. The lower-ranked offices started the process of unlocking and removing the seals and then moved to the next ranked offices to do the same. During the event, they broke the locks and placed the seals on the tables with candles and incense. And then the official presented himself before the seal, and the master of ceremonies bestowed the seal upon him again.[31]

Frontier societies shared the timing of the seal closing and bestowal but transformed it into a steppe tradition. In the case of Mongolia, because the civil office overlapped with the authority of the banner prince, the closing and opening of the seal ceremonies were even more connected to the reproduction of local authority. First, in the late autumn, the Astronomical Bureau published nationwide notices for government offices that identified the auspicious date and time for when to wear official ceremonial clothes and to conduct the locking up and opening up of the seals. These documents included Mongolian territories. Upon receiving the notification, the governor-general then sent out reports of the times to the officials of the various khanates, banners, and sum.[32] These

[30] Justus Doolittle, *Social Life of the Chinese: With Some Account of Their Religious, Governmental, Educational and Business Customs and Opinions*, vol. 2 (Harper & Bros, 1865), 80-81.
[31] Justus Doolittle, *Social Life of the Chinese: With Some Account of Their Religious, Governmental, Educational and Business Customs and Opinions*, vol. 2 (Harper & Bros, 1865), 38-39.
[32] NAM, M-1 Folder 1 File 3507, Document 1; M-1 Folder 1 File 4256, Document 6; M-1 Folder 1 File 4282, Document 2; M-1 Folder 1 File 4300, Document 14; M-1 Folder 1 File 4300, Document 15 ; M-1 Folder 1 File 4327, Document 30 ; M-1 Folder 1 File 4327, Document 32

offices were composed of both buildings and tents.[33] Although the buildings were constructed in Chinese style and usually contained the items related to the government storehouse for the office, this was not the case for the seals.[34] The seals were kept in special spaces. If a prince were traveling, the seal would be kept in a portable box that was strapped to a seal-bearer who transported the seal in front of the prince (see Appendix Figure A 1).[35] During the night and closing times, the seal was also kept in special tents with incense and burning lamps. The tent was guarded and watched during such periods of closing.[36]



Appendix Figure A 1: Mongolian illustration of traveling with the seal. The image depicts a Mongolian noble traveling with his seal. The seal is carried in the backpack of the third rider. Source: James Gilmour, *Among the Mongols* (The Religious Tract Society, 1888), 306-307

The ceremony for opening the seal was a part of bringing the community together. During this event, the princes of the seal gathered the various officials and held a special meeting for the seal.[37] Similar to the Chinese case, this ritual also had a ceremonial official who regulated the event and maintained ritual continuity, the same kind of official involved in marriages and burials.[38] As

[33] Antoine Mostaert, "Materiaux Ethnographiques Relatifs Aux Mongols Ordos," *Central Asiatic Journal* 2, no. 4 (1956): 253.; Alekseĭ Matveevich Pozdneev, *Mongolia and the Mongols*, vol. 1, ed. John R. Krueger, trans. John Roger Shaw and Dale Plank (Indiana University, 1971), 10.
[34] Antoine Mostaert, "Materiaux Ethnographiques Relatifs Aux Mongols Ordos," *Central Asiatic Journal* 2, no. 4 (1956): 253.; Alekseĭ Matveevich Pozdneev, *Mongolia and the Mongols*, vol. 1, ed. John R. Krueger, trans. John Roger Shaw and Dale Plank (Indiana University, 1971), 10.
[35] James Gilmour, *Among the Mongols* (The Religious Tract Society, 1888), 305-307.
[36] Antoine Mostaert, "Materiaux Ethnographiques Relatifs Aux Mongols Ordos," *Central Asiatic Journal* 2, no. 4 (1956): 253
[37] Antoine Mostaert, "Materiaux Ethnographiques Relatifs Aux Mongols Ordos," *Central Asiatic Journal* 2, no. 4 (1956): 251 ; Antoine Mostaert, "L'«Ouverture Du Sceau» Et Les Adresses Chez Les Ordos," *Monumenta Serica* 1, no. 2 (1935): 315–37.
[38] Antoine Mostaert, "L'«Ouverture Du Sceau» Et Les Adresses Chez Les Ordos," *Monumenta Serica* 1, no. 2 (1935): 316.

a part of the ceremony, the ritual overseer would make a statement that reaffirmed the connection of imperial grace and its gift to the Mongol prince.[39]

Imperial calendars were a key part of this ritual process. Imperial calendars structured what days were chosen for holding these events and community rituals. And the calendars had their own signals within the entire event. For instance, because the calendar distribution process largely occurred in the twelfth month, the distribution of the calendar to the princes often occurred during the process of closing and opening the seals. This occurred in the case of Coinjub, one of the princes of Qarulun-u bars. He held a gathering to collect the calendar, but he conducted it on the first day of the new year.[40] This was not a unique case.[41] The calendar might only arrive by the time of the opening seal. For instance, Gung Sonomwangcuga of Qan aġula received his calendars as a part of the gathering. He included them in his note from the twenty-fifth day of the first month of the New Year.[42]

The distribution of the calendar then was a much richer part of the material life for constructing authority. As a part of the 1827 Russian embassy, George Timkowski claimed that once the Khalkha Mongols they had accepted submission to enter the Qing Empire. "By receiving the Almanack of Peking, a foreign prince declares himself a vassal of the empire."[43] But the reality on the ground was far more complicated than this idea might claim. Calendars were always subject to manipulation. And because the Mongols did not usually even receive the physical prints of the calendars until the New Year had already started, Qing calendars were far more significant in building up the local power of princes rather than the general power of the state. Mongolian-language calendars were important, because they had become another interface in connecting communities.

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[39] Antoine Mostaert, "L'«Ouverture Du Sceau» Et Les Adresses Chez Les Ordos," *Monumenta Serica* 1, no. 2 (1935): 316. ; Christopher Atwood, "'Worshiping Grace': The Language of Loyalty in Qing Mongolia," *Late Imperial China* 21, no. 2 (2000): 104.

[40] NAM M-1 Folder 1 File 3816 Document 2

[41] NAM M-1 Folder 1 File 4016 Document 6; NAM M-1 Folder 1 File 4016 Document 8

[42] NAM M-1 Folder 1 File 3816 Document 6

[43] George Timkowski, *Travels of the Russian Mission through Mongolia to China, and Residence in Pekin, in the Years 1820-1821*, 2 vols. (Longman, Rees, Orme, Brown, and Green, 1827), 213.

Appendix B: Tables and Figures

	Calendars without State Seals								
	Emperor	**Grand Empress Dowager**	**Empress Dowager**	**Empress Consort**	**Imperial Noble Consort**	**Noble Consort**	**Consorts**	**Concubines**	**Imperial Princes**
Calendar Types	*Imperial Calendar*								
	People's Calendar	*People's Calendar*	*People's Calendar*	*People's Calendar*	*People's Calendar*	*People's Calendar*	*People's Calendar*	*People's Calendar*	*People's Calendar*
	Seven Luminaries Calendar	*Seven Luminaries Calendar*	*Seven Luminaries Calendar*	*Seven Luminaries Calendar*	*Seven Luminaries Calendar*	*Seven Luminaries Calendar*	*Seven Luminaries Calendar*	*Seven Luminaries Calendar*	*Seven Luminaries Calendar*
Languages	*Chinese*	*Chinese*	*Chinese*	*Chinese*	*Chinese*	*Chinese*	*Chinese*	*Chinese*	*Chinese*
	Manchu	*Manchu*	*Manchu*	*Manchu*	*Manchu*	*Manchu*	*Manchu*	*Manchu*	*Manchu*
Containers	*Yellow (Imperial) silk damask book covers*	*Yellow (Imperial) silk damask book covers*	*Yellow (Imperial) silk damask book covers*	*Yellow (Imperial) silk damask book covers*	*Yellow (Golden) silk damask book covers*	*Yellow (Golden) silk damask book covers*	*Yellow (Golden) silk damask book covers*	*Red silk covers*	*Yellow (Golden) silk damask book covers*
Cover	*Yellow (Imperial) silk cloth wrapper with gold clasp*	*Yellow (Imperial) silk cloth wrapper with gold clasp*	*Yellow (Imperial) silk cloth wrapper with gold clasp*	*Yellow (Imperial) silk cloth wrapper with gold clasp*	*Yellow (Gold) silk cloth wrapper with gold clasp*	*Yellow (Gold) silk cloth wrapper with gold clasp*	*Yellow (Gold) silk cloth wrapper with gold clasp*	*Red silk cloth wrapper with gold clasp*	*Yellow (Imperial) plain silk cloth wrapper*

Appendix Table B 1: Calendar types and status, without state seals. Sources: Administrative Regulations

	Calendars with State Seals										
	Imperial Relation	**Princes**	**Beile**	**Beizi**	**Gong Dukes**	**Gurun Princess**	**Princess**	**Manchu Official**	**Mongolian Official**	**Chinese Bannermen**	**State Officials**
Calendar Types	*People's Calendar*	*People's Calendar*	*People's Calendar*	*People's Calendar*	*People's Calendar*	*People's Calendar*	*People's Calendar*	*People's Calendar*	*People's Calendar*	*People's Calendar*	*People's Calendar*
	Seven Luminaries Calendar	*Seven Luminaries Calendar*	*Seven Luminaries Calendar*	*Seven Luminaries Calendar*	*Seven Luminaries Calendar*	*Seven Luminaries Calendar*	*Seven Luminaries Calendar*				
Languages	*Chinese*	*Chinese*	*Chinese*	*Chinese*	*Chinese*	*Chinese*	*Chinese*			*Chinese*	*Chinese*
	Manchu	*Manchu*	*Manchu*	*Manchu*	*Manchu*	*Manchu*	*Manchu*	*Manchu*			
									Mongolian		
Containers	*Red silk covers*	*Red silk covers*	*Red silk covers*	*Yellow paper covers*	*None*	*Red silk covers*	*Yellow paper covers*	*None*	*None*	*None*	*None*
Cover	*Red silk cloth wrapper with gold clasp*	*Red silk cloth wrapper with gold clasp*	*Red tissue paper wrapper*	*Red silk cloth wrapper with gold clasp*	*Red silk cloth wrapper with gold clasp*	*Red silk cloth wrapper with gold clasp*	*Red silk cloth wrapper with gold clasp*	*None*	*None*	*None*	*None*

Appendix Table B 2: Calendar types and status, with state seals. Source: Administrative Regulations

Appendix C: Zhang Zuonan's Collectanea of Classical Works

The most important work was Zhang's collectanea on mathematics which carried on a long life through several republications. Named the *Cuiweishan fang shuxue* 翠微山房數學, this was a collection of 38 different volumes that eventually coalesced into a single series (see Appendix Table C 1). The publication grew over time as Zhang added more volumes to the collection based on various needs.[1] Some of the earliest volumes emerged from the teaching notes that Zhang had produced as a part of his Meiyi studio. The first printed edition in 1820 included at least 16 juan or volumes. The earliest books in the series were explanations on how to do quick calculations of different volumes. Some of these books had been in draft form since at least 1816, because they were edited by Fan Jingfu 范景福 (? - 1816) shortly before he died.[2] Then, from late 1819 to early 1820, not long after he had moved to Changzhou, Zhang invited Jiang Lintai to join his staff based on the recommendation of a friend. Jiang Lintai completed the manuscript and added illustrations for many of the mathematical examples. In 1820, Zhang and Jiang collaborated on several more treatises that provided additional explanatory models for astronomical mathematics and spherical trigonometry. [3]

[1] For comparisons with similar collected volumes, see Suyoung Son, *Writing for Print: Publishing and the Making of Textual Authority in Late Imperial China* (Harvard University Asia Center, 2018). Chapters 1, 2; Bian He, "Re-Collecting the Glorious Age: Yang Fuji and the Disciplining of Zhaodai Congshu, 1772–1844," *Late Imperial China* 40, no. 1 (2019): 1–41.; Wang, "Agency in the Margins."151-165

[2] Zhang Zuonan, *Fang Tian Tong Fa Bu Li 方田通法補例*, CWSFSX (1820). j.6, 34a

[3] Zhang, *Chuai Yue Xiao Lu*. 1b ; Zhang, *Hu Jiao She Ru*. Qi Yanhuai preface 齊彥槐序, 1a

Appendix Table C 1: List of Book Titles from *Cui wei shan shu xue*. Sources: Cuiweishan shuxue editions; Jinhua xian zhi (Guangxu), j.15, 15b

Title, Pinyin	**Title, Characters**		**Date**
Cang tian tong fa	倉田通法		1820
Liang cang tong fa		量倉通法	1820
Jie gen fang fa		借根方法	1820
Fang tian tong fa bu li		方田通法補例	1820
Cang tian tong fa xu bian		倉田通法續編	1820
Ba xian lei bian	八綫類編		1820
Ba xian dui shu lei bian	八綫對數類編		1820
Hu jiao she ru	弧角設如		1820
Hu jiao ju yu	弧角舉隅		1820
Chuai yue xiao lu	揣籥小錄		1820
Chuai yue xu lu	揣籥續錄		1820
Gao hu xi cao	高弧細草		1821
Xin ce heng xing tu biao	新測恆星圖表		1823
Xin ce zhong xing tu biao	新測中星圖表		1823
Geng lou zhong xing biao	更漏中星表		1823
Jiang nan geng lou zhong xing biao	江南更漏中星表		1823
Zhe jiang geng lou zhong xing biao	浙江更漏中星表		1823
Jin hua ri lou zhong xing biao	金華晷漏中星表		1823
Jiao shi xi cao	交食細草		1823
Dui shu yong fa	對數用法		manuscript
Dui shu chi yong fa	對數尺用法		manuscript
Ce suan qi fan	測算器繁		manuscript
Gou gu shuo	勾股說		manuscript
Wu geng suan cao	五更算草		manuscript

According to bibliographies, the first editions of the collectanea were printed by two different publishers. One edition was based on a series of blocks contained in the Xiyuan Library 息園藏版. Another version of the first edition explicitly stated that it was cut and published by Zhang's own Cuiweishan studio.[4] Then, in 1823 and 1824, Zhang expanded the collected volumes. He added more treatises that explained practical applications for the astronomical mathematics with treatises on timekeeping. These titles included his guides for checking times, explanations on building sundials, and practical exercises in verifying various forms of time measurement.[5]

The series continued to be published throughout the 19th century, even after Zhang's death. In the 1830s and 1840s, because Jiang Lintai was one of the main collaborators on almost all of the technical literature, Jiang also republished some of the work through his own studio name and local printers.[6] During the Tongzhi reign (1861-1874), another studio republished the volumes. Then the work was recirculated through several additional reprints by various private publishers in both woodblock and lithography.[7] Furthermore, according to the Jinhua gazetteer, there were additional volumes which were supposed to be added to the series but only remained in manuscript form at the end of the Qing.[8]

These works also contributed to Zhang's broader initiatives to circulate his ideas. For instance, Zhang's own writings were attached to his historical reprint collection. When he returned to his hometown after service, he also started to work on a long-term project connected to the study of Tang Zhongyou 唐仲友 (1136-1188), a Song-period scholar from Jinhua who specialized in the *Book of Poetry* like Zhang Zuonan. Zhang then published a special series focused solely on Tang's scholarship and collected works called *Jinhua Tang shi yishu wu zhong fu yi zhong* 金華唐氏遺書五種附一種.[9] According to biographies and bibliographies, Zhang

[4] Li, *Zhongguo Suan Xue Shu Mu Hui Bian*. 594-595
[5] Li, *Zhongguo Suan Xue Shu Mu Hui Bian*.595
[6] Compare some of the editions reprinted in Jiang's collected works. Lintai 江臨泰 Jiang, *Jiang Lintai Ji 江臨泰集*, 3 vols., Quanshu Gu Dai Dian Ji Cong Shu (Guo jia tu shu guan chu ban she, 2020).
[7] Li, *Zhongguo Suan Xue Shu Mu Hui Bian*.595-596
[8] Deng Zhongyu, ed., *Guangxu Jinhua Xian Zhi 光緒金華縣誌* (Wuxian Qian Renlong, 1915). j.15, 15b
[9] For a modern reprint of this work, see Tang Zhongyou, *Jin Hua Tang Shi Yi Shu Wu Zhong Fu Yi Zhong 金華唐氏遺書五種附一種*, ed. Zuonan 張作楠 Zhang (Henan renmin chuban she, 2018).

also published several sets of personal notes on his classical scholarship.[10] For instance, the Jinhua gazetteer listed several of his private study notes as a local product.[11] But one of the most successful copies of his notes was his *Meiyi suibi* 梅簃隨筆. The *Meiyi suibi* included notes from 1813-1818 when he taught in Chuzhou, and it was printed by one of his students Yu Jun 俞俊 in 1819.[12]

In addition to his correspondence and personal poetry, Zhang Zuonan also constructed and built material objects that he shared and sold with his books (see Appendix Table C 2). For instance, the manuscript copies that were not yet added to the mathematical compendium included two books specifically on mathematical instruments. The instruments included sectors ("on using the lines for logarithms" 對數尺用法) as well as general classes of "calculating instruments". Although Zhang was proficient in the use of pen-based mathematics, the calculating instruments likely referred to a manual on using calculating rods, strips of numbers that were based on Napier's bones which had popular appeal in the early 19th century.[13] In his writings, Zhang indicated that he had several other materials that individuals could combine with his books, such as maps and visual aids.[14]

[10] Xu, *Qing Ru Xue An*. j. 128, 5055
[11] Deng, *Guangxu Jinhua Xian Zhi*. j. 15, 14b
[12] Zhang, *Mei Yi Sui Bi*.
[13] Although rod-based mathematics had been practiced until the Song period, this calculating tool had been largely replaced by the simpler abacus. Nevertheless, with the introduction of Jesuit translations on Napier's bones, followed by the recovery of Chinese mathematics in the late Qianlong and Jiaqing periods, counting rods returned to scholar culture as a revered tool for learning how to calculate. Suddenly, in the first half of the 19th century, rod-based mathematics became one of the most popular forms of calculation among elites. Popular novels also started to print the method. I plan to work more on this question in the future. For some broad overviews of this change, see Yu Wang Luen, "Knowledge of Mathematics and Science in Ching-Hua-Yüan," *Oriens Extremus* 21, no. 2 (1974): 217–36.; Li and Du, *Chinese Mathematics: A Concise History*. 6-18, 211-212; Elman, *On Their Own Terms: Science in China 1550-1900*. 275-276; José Antonio Cervera Jiménez, *Las Varillas de Napier En China: Giacomo Rho, S. J. (1592-1638) y Su Trabajo Como Matemático y Astrónomo En Beijing* (El Colegio de Mexico, 2011). 171-260 ; Alexei Volkov, "Chinese Counting Rods: Their History, Arithmetic Operations, and Didactic Repercussions," in *Computations and Computing Devices in Mathematics Education Before the Advent of Electronic Calculators*, ed. Alexei Volkov and Viktor Freiman (Springer, 2019). 137-188
[14] Zhang, *Xin Ce Heng Xing Tu Biao*. Preface, 2a

Appendix Table C 2: List of instruments attributed to Zhang Zuonan. Source: Compiled from *Cuiweishan shuxue*

Instrument Type	**Examples**
Sundials	*Vertical, horizontal, pillar (altitude), latitude-adjusting east-west vertical*
Tables	*Gazetteer of Districts in Empire; Logarithms; Trigonometric Ratios; Timetables for Night-watchmen*
Maps	*Planispheric star charts; zhongxing charts (Meridian-star charts)*
Globes	*Printed gores for celestial globe*
Calculators	*Sectors (proportional dividers); rulers; Napier's rods*
Drawing Instruments	*Rulers, compasses*

Zhang's studio Cuiweishan supported additional efforts to print older texts through the popular form of the collectanea. Building perhaps on his family's older library, Zhang reprinted more than 40 separate books of the Zhejiang scholarship in collectanea of Song to Ming scholars (see Appendix Table C 3). That the family library was a part of this process is likely related to the fact that Zhang's studio name is connected to an edition of poetry by one Jin Zhang 金璋 (? - 1849), one of Zhang's maternal kin. The book came from Jin's own studio, but the edition was cut and published from the Cuiweishan studio.[15]

[15] Jin Zhang, *Cui Wei Shan Fang Yin Gao 翠微山房吟稿* (1835), Renmin daxue tushuguan.

Appendix Table C 3: List of Books Published in Cui wei shan collectanea. Source: Zhejiang Provincial Library

Book Title, Pinyin	**Book Title, Characters**	**Author/Compiler, Pinyin**	**Author/Compiler, Characters**
Jiu jing fa ti	九經發題一卷	Tang Zhongyou	宋唐仲友撰
Gu zhou yi	古周易一卷	Lü Zuqian	宋呂祖謙輯
San guo ji nian	三國紀年一卷	Chen Liang	宋陳亮撰
Zheng nan lu	征南錄一卷	Sheng Yuanfa	宋勝元發撰
Geng yue ji	艮嶽記一卷	Zhang Hao	宋張淏撰
Ge xiang xin shu	革象新書二卷	Zhao Youqin, Wang Weice	元趙友欽撰, 明王禕刪定
Zhu Zhai shi yu	竹齋詩餘一卷	Huang Ji	宋黃機撰
Yu shu	愚書一卷	Tang Zhongyou	宋唐仲友撰
Wo you lu	臥遊錄一卷	Lü Zuqian	宋呂祖謙撰
Jin hua you lu	金華遊錄一卷	Fang Feng	宋方鳳撰
Nan hai gu ji ji	南海古蹟記一卷	Wu Lai	宋吳萊撰
Long men zi ning dao ji	龍門子凝道記三卷	Song Lian	明宋濂撰
Feng shan y ulu	楓山語錄一卷	Zhang Mao	明章懋撰
Long chuan ci, bu yi	龍川詞一卷補遺一卷	Chen Liang	宋陳亮撰
Shu ji zhuan you wen	書集傳或問二卷	Chen Dayou	宋陳大猷撰
Qing xi kou zhe	青溪寇軌一卷	Fang Shao	宋方勺撰
Hua chuan yi ci	華川巵辭一卷	Wang Wei	明王禕撰
Chou gu lun	酌古論四卷	Chen Liang	宋陳亮撰
Ru yue ji	入越記一卷	Lü Zuqian	宋呂祖謙撰
Yue cheng yi yan	樂城遺言一卷	Su Zhou	宋蘇籀記
Ge zhi yu lun	格致餘論二卷	Zhu Zhenheng	元朱震亨撰
Ju fang fa hui	局方發揮一卷	Zhu Zhenheng	元朱震亨撰
Chun qiu zuo zhuan shuo	春秋左氏傳説二十卷	Lü Zuqian	宋呂祖謙撰
Shu yi	書疑九卷	Wang Bo	宋王柏撰

Shi yi	詩疑二卷	Wang Bo	宋王柏撰
Ri sun zhai bi ji, fu lu	日損齋筆記一卷附錄一卷	Huang Jin	元黃溍撰
Shao yi wai zhuan	少儀外傳二卷	Lü Zuqian	宋呂祖謙撰
She shi sui bi	涉史隨筆一卷	Ge Hong	宋葛洪撰
Zhong xing lun	中興論一卷	Chen Liang	宋陳亮撰
Zhu zi bian	諸子辨一卷	Song Lian	明宋濂撰
Yuan zhen zi	元真子三卷	Zhang Zhihe	唐張志和撰
Wu qi da you shi shu	五氣大有實書一卷	Song Lian	明宋濂撰
Shi ji zhuan ming mu chao	詩集傳名物鈔八卷	Xu Qian	元許謙撰
Ying xue cong shuo	螢雪叢說二卷	Yu Cheng	宋俞成撰
Luo shan za yan	蘿山雜言一卷	Song Lian	明宋濂撰
Yan shu si shi pian	燕書四十篇一卷	Song Lian	明宋濂撰
Wu li bu shi hua	吳禮部詩話一卷	Wu Shidao	元吳師道撰
Shao bao shan fang bi cong zheng ji, xu ji	少寶山房筆叢正集三十二卷續集十六卷	Hu Yinglin	明胡應麟撰
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Si shu cong shuo	四書叢說八卷	Xu Qian	元許謙撰
Yun gu za ji	雲谷雜記四卷	Zhang Hao	宋張淏撰
Bo zhai bian	泊宅編三卷	Fang Shao	宋方勺撰
Ben bo zhai bian	宋本泊宅編十卷	Fang Shao	宋方勺撰
Cui wei shan fang wen chao	翠微山房文鈔不分卷	Zhang Zuonan	清張作楠撰

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QSG. Qing shi gao 清史稿 (Draft History of the Qing).

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GZD. Qing dai gong zhong dang zou zhe 宮中檔奏摺 (Qing Palace Memorials).
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