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The Jesuit Role as "Experts" in High Qing Cartography and Technology*

Benjamin A. Elman**

Abstract

Earlier accounts have generally overvalued or undervalued the role of the Jesuits in Ming-Qing intellectual life. In many cases the Jesuits were less relevant in the ongoing changes occurring in literati learning. In the medical field, for example, before the nineteenth century few Qing physicians (*ruyi* 儒醫) took early modern European "Galenic" medicine seriously as a threat to native remedies. On the other hand, the Kangxi revival of interest in mathematics was closely tied to the introduction of Jesuit algebra (*jiegen fang* 借根方), trigonometry (*sanjiao xue* 三角學), and logarithyms (*duishu* 對數). In the midst of the relatively "closed door" policies of the Yongzheng emperor and his successors, a large-scale effort to recover and collate the treasures of ancient Chinese mathematics were prioritized in the late eighteenth and early nineteenth century.

Despite setbacks during the early eighteenth century Rites Controversy, the Jesuits in China remained important "experts" (專家) in the Astro-Calendric Bureau (欽天監) and supervisors in the Qing dynasty's imperial workshops. Earlier Adam Schall (1592-1666) and Ferdinand Verbiest (1623-1688) had not only championed the role of mathematics in Christianizing literati elites, but they also produced instruments and weapons at the behest of both the Ming and Qing dynasties. The technical expertise of the Jesuits in the China mission during the eighteenth century also ranged from translating Western texts and maps, introducing surveying methods to producing cannon, pulley systems, sundials, telescopes, water-pumps, musical instruments, clocks, and other mechanical devices. Their European enemies accused the Jesuits of making themselves useful to local rulers for their personal advantage rather than in the name of Christianity.

Keywords: Jesuits, geography, experts, glass making, clocks, architecture.

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** Professor of East Asian Studies and History, Princeton University.

Earlier accounts have generally overvalued or undervalued the role of the Jesuits in Ming-Qing intellectual life. In many cases the Jesuits were less relevant in the ongoing changes occurring in literati learning. In the medical field, for example, before the nineteenth century few Qing physicians (*ruyi* 儒醫) took early modern European "Galenic" medicine seriously as a threat to native remedies. Instead, most were determined to pierce the veil of Song metaphysical and cosmological systems that since the Jin and Yuan periods had been inscribed in the theory and practice of traditional Chinese medicine. They sought to recapture the pristine meanings formulated in the medical classics of antiquity. They called into question the dominant framework of analysis, which Jin-Yuan-Ming physicians, following Song precedents, had enshrined as the theoretical norm in medical texts and casebooks.[1]

On the other hand, the Kangxi revival of interest in mathematics was closely tied to the introduction of Jesuit algebra (*jiegen fang* 借根方), trigonometry (*sanjiao xue* 三角學), and logarithyms (*duishu* 對數). As a result, Mei Juecheng 梅稼成(1681-1763) and others realized that they no

1 On the Song, see Asaf Goldschmidt, *The Transformations of Chinese Medicine During the Northern Sung Dynasty (960-1126 A.D.): The Integration of Three Past Medical Approaches into a Comprehensive Medical System Following a Wave of Epidemics* (Philadelphia: University of Pennsylvania Ph.D. dissertation in the History and Sociology of Science, 1999). See also Chu Pingyi, "Tongguan Tianxue, Yixue yu Ruxue: Wang Honghan yu Ming-Qing Zhi Ji Zhongxi Yixue de Jiaohui" 通貫天學, 醫學與儒學:王宏翰與明清之際中西醫學的交會, *Lishi yuyan yanjiu suo jikan* 歷史語言研究所集刊 70. 1 (1999, Taiwan): 165-201, for an example of the impact of European medicine in the seventeenth century.

longer had access to many of the works originally included in the medieval *Ten Computational Classics* (*Shibu suanjing* 十部算經). Moreover, in addition to the *Sea Mirror of Circular Measurement* (*Ceyuan haijing* 測圓海鏡) of 1248, which was the oldest extant work on the "single unknown" (*tianyuan shu* 天元術) technique for algebra, the seminal works of Song-Yuan literati mathematicians on polynomial algebra (*siyuan shu* 四元術) were unavailable in Mei Wending's 梅文鼎 (1633-1721) time.

In the midst of the relatively "closed door" policies of the Yongzheng emperor and his successors, a large-scale effort to recover and collate the treasures of ancient Chinese mathematics were prioritized in the late eighteenth and early nineteenth century. In addition to famous scholars such as Dai Zhen 戴震 (1724-1777), Qian Daxin 錢大昕 (1728-1804), Ruan Yuan 阮元 (1764-1849), and Jiao Xun 焦循 (1763-1820) who stressed mathematics in their research, the editing of ancient mathematical texts and the continued digesting of European mathematical knowledge was carried out by a series of literati mathematicians who were also active in evidential studies (*kaozheng xue* 考證學). Through the recovery and collation of ancient mathematical texts, the alleged superiority of Jesuit mathematics was increasingly disparaged by Qing scholars who appealed to the "Chinese origins of Western Learning" (*Xixue Zhongyuan* 西學中源) as a historical reality and not just a political tactic to justify calendrical reform.[2]

Despite setbacks during the early eighteenth century Rites Controversy, the Jesuits in China remained important "experts" (專家) in the Astro-Calendric Bureau (欽天監) and supervisors in the Qing dynasty's imperial workshops. The technical expertise of the Jesuits in the China mission during the eighteenth century also ranged from translating Western texts and maps, introducing surveying methods to producing cannon, pulley systems, sundials, telescopes, water-pumps, musical instruments, clocks, and other mechanical devices. Their European enemies accused the Jesuits of

2 See my "Western Learning and Evidential Research in the Eighteenth Century," *Gugong jikan* 故宮季刊(Taipei), forthcoming.

making themselves useful to local rulers for their personal advantage rather than in the name of Christianity. Adam Schall (1592-1666) and Ferdinand Verbiest (1623-1688) not only championed the role of mathematics in Christianizing literati elites, but they also produced instruments and weapons at the behest of both the Ming and Qing dynasties.[3]

While in Beijing, for example, the French Jesuits Michel Benoist and Jean-Joseph-Marie Amiot interested themselves in electricity. In 1755 they sent a report of their tests to St. Petersburg. Such experiments were kept secret. In 1773, Benoist demonstrated an air pump to the Qianlong emperor, who decided that the proper name for the device would be a "pipe to wait for the *qi*" (*houqi tong* 候氣筒), a reference to the perennial efforts by the Astro-Calendric Bureau to determine the onset of spring by measuring the *qi* emanating from the earth, which the Kangxi emperor had ridiculed early in his reign.[4]

In 1645, for instance, Schall had gone through the motions of submitting a report about the "waiting for the *qi*" (*houqi* 候氣) procedures used by the Bureau to determine the onset of spring within a fortnightly period, whose precise timing was one of the Bureau's charges. "Waiting for the *qi*" was a technique for measuring the earth's emanations that had changed over time. It had switched from a method to establish the correct dimensions of the musical pitch pipes, whose ratios were used for weights and measures, to one measuring the onset of the fortnightly periods. The procedures associated with "waiting for the *qi*" involved burying twelve musical pitch pipes of graduated lengths in a sealed chamber and filling the pipes with ashes

3 Li Bin 李斌, "Xishi wuqi dui Qingchu zuozhan fangfa de yingxiang" 西式武器對清初作戰方法的影響 (The impact of Western style weapons on combat techniques in the early Qing), *Ziran bianzheng fa tongxun* 自然辯證法通訊 24. 4 (2002): 45-53.

4 J. L. Heilbron, *Electricity in the 17th and 18th Centuries: A Study of Early Modern Physics* (Berkeley: University of California Press, 1979), 121, 352, 405. See also Joseph Needham and others, *Science and Civilisation in China* (Multi-volumes. Cambridge: Cambridge University Press, 1954-), hereafter SCC, Volume 3, 450-451. Compare Stephen Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* (Princeton: Princeton University Press, 1989).

produced by burning the pith of a reed. In antiquity it had been believed that when the sun entered the second fortnight of any month, the earth's *qi* as a seminal force would rise and expel the ashes from the pipes.[5]

When Yang Guangxian 楊光先 (1597-1669) brought his famous 1664 suit against the Jesuits, their attitude toward "waiting for the *qi*" as a means to determine auspicious dates (吉凶= "hemerology") became a focus of Yang's attacks. Yang accused Schall of relying on his own calculations and ignoring the old system to determine the onset of spring. When Schall replied that system had been in decline and was no longer used by his predecessors in the Ming Astro-Calendric Bureau, however, the court noted that he had earlier ascertained the onset of spring by using the "waiting for the *qi*" method. The Kangxi regents were unhappy with Schall's pretences, because they meant that the timing of the onset of spring had never really been verified based on the old system.[6]

The political background for Yang Guangxian's anti-Christian attacks makes it clear that the role of the Astro-Calendric Bureau in determining auspicious days had continued under the Jesuits, much to the dissatisfaction of other Catholic orders in China who were opposed to astrology and hoped to Christianize imperial "time." Schall had underestimated how the intertwining of astronomy, "waiting for the *qi*" traditions, and *yin-yang* numerology in telling fortunes and determining auspicious days might ensnare the Jesuit mission in a calendrical battle where predicting eclipses would not be the key issue. These claims suggested that the Jesuits were organizing converts to plot against the dynasty.

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5 Derk Bodde, "The Chinese Cosmic Magic known as Watching for the Ethers," in Soren Egerod and Elise Glahn, eds., *Studia Serica Bernhard Karlgren Dedicata, Sinological Studies Dedicated to Bernhard Karlgren on His Seventieth Birthday October Fifth 1959* (Copenhagen: Ejnar Munksgaard, 1959), 14-35, argues that the practice was in disrepute by the sixteenth century.

6 Huang Yi-long, "Court Divination and Christianity in the K'ang-hsi Era," *Chinese Science* 10 (1991): 1-20, and Huang Yi-long and Chang Chih-ch'eng, "The Evolution and Decline of the Ancient Practice of Watching for the Ethers," *Chinese Science* 13 (1996): 82-85, 90-96, 104.

In late 1668 Verbiest, as Schall's successor in the Bureau, was able to make the case that "using reed pipes and flying ashes" was no way to measure the twenty-four fortnightly periods of the year. Verbiest argued that the onset of spring was determined by the intersection of the sun with the equatorial, a completely different orientation from Yang's focus on "waiting for the *qi*." The Kangxi emperor endorsed Verbiest's calculations, but the Jesuits still had to follow traditions associated with the cosmological and ritual aspects of the calendar. We will see that the Kangxi emperor also relied on Verbiest and the Jesuits to mediate between the Qing and Russian empires when their geographic borders expanded in the 1670s and 1680s.[7]

After 1670, the Jesuits depended almost exclusively on Manchu imperial patronage of their technical expertises and not on the support of Chinese literati. The opposite had been the case in the late Ming when literati had been the order's stalwarts and sanctioned the quest for converts. Literati scholars who were leaders in the eighteenth century turn toward evidential studies recognized the importance of European studies, particularly mathematics and astronomy, but remained suspicious of the Jesuits' motives in coming to China.[8]

After 1735, few classical scholars had any contact with the Jesuits who remained in China, even though many were still prominent in the Qianlong court as architects and glassmakers. Most intellectual issues addressed by Han Learning scholars, for instance, revolved around the complexities of the native classical heritage and its misrepresentations in accounts by followers of Song and Ming "Learning of the Way."(道學) The Jesuits were reduced from the intellectual equals of classically trained literati to foreign experts whose special skills entitled them to a lower status in the bureaucracy as official minions of the emperor.

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7 Huang and Chang, "The Evolution and Decline," 95-97, and Chu Pingyi, "Scientific Dispute in the Imperial Court: The 1664 Calendar Case," *Chinese Science* 14 (1997): 7-34.

8 Huang and Chang, "The Evolution and Decline," 99.

I. Mensuration and Cartography in the Eighteenth Century

In geography, for instance, Qing scholars during the late seventeenth and eighteenth centuries reacted to the Jesuit contributions in world geography by domesticating such new knowledge in the midst of Manchu empire building and the court's use of Jesuit surveying techniques to measure its domains. At the same time that the dynasty took advantage of international changes in Central Asia, literati took an internalist turn intellectually by focusing on native topics in their new geographic works.[9]

The late Qianlong compilers of the 1787 edition of the *Comprehensive Analysis of Civil and Military Institutions during the Qing Dynasty* (皇朝文獻通考), which included documents and materials covering the period 1644-1785, demoted the mention of Europe to a minor section on Italy within the category of the "Four Frontiers" (四裔).Twenty-four chapters in the traditional category of "Geography and Lands" (輿地) dealt with imperial domains, while only eight covered the borderlands. The compilers of the "Four Frontiers" focused on Korea, the Ryukyu Islands, Vietnam, and other neighboring tributary countries.

The section on Italy mentioned that "what the Italians [i.e., Matteo Ricci] had said about the division of the world into five continents followed from Zou Yan's 鄒衍 Warring States theory of the Sacred Ocean (神海), although the Italians dared to add that the land of China was but one of the five continents" (五大洲). Such claims infuriated the compilers who dismissed the Italians as too grandiose. They could not be taken seriously because they were simply trying to impress Chinese with European customs, goods, governance, and education. By citing Zou Yan on the question of continents, the *Comprehensive Analysis* was drawing on a long tradition of classical interpretation that the ancient "nine regions" (九州) were sur-

9 See Benjamin Elman, *From Philosophy to Philology: Social and Intellectual Aspects of Change in Late Imperial China* (Second edition. Los Angeles: UCLA Asia Pacific Monograph Series, 2002), 72-122.

rounded by oceans and thus the geographic term for "regions" (州) could also serve as a native term for "continent."[10]

Still, the *Comprehensive Analysis* included detailed geographic discussions of Europe and Russia. Moreover, the dramatic impact that European surveying methods had in China early in the eighteenth century continued to pique the interest of the Qianlong emperor and his literati in court when the Kangxi map of the empire (天下全圖) was updated using European surveying methods. European geographical content may have been overlooked, but European methods were still admired and copied in geography as well as astronomy.[11]

Xue Fengzuo 薛鳳祚 (1600-1680) studied astronomy and mathematics under the Jesuit Jean-Nicholas Smogolenski. Xue then applied the techniques of spherical trigonometry and logarithms to surveying, which was appreciated by the Qianlong Imperial Library editors in their review of Xue's *Compendium on the Yellow River and Grand Canal* (兩河清彙). The editors noted that Xue's mathematical expertise was an invaluable aid in analyzing problems related to flood control and canal upkeep. His use of European trigonometry was recognized as a clear improvement over the native forms of trigonometry known as "double application of proportions" (*chongcha* 重差, i.e. properties of right triangles expressed as a function of angles), which had dominated Chinese surveying techniques until that time.[12]

Although the internal turn in Qing geographic research did not produce a cartographic reconceptualization of foreign lands, we should not underestimate Jesuit and European cartographic influence in China. Through systematic gathering of materials that they would then critically scrutinize and in some cases quantify, Qing scholars combined evidential research meth-

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10 *Huangchao wenxian tongkao* 皇朝文獻通考, in *Shitong* 十通(The ten comprehensive encyclopedias of civil and military governance) (Shanghai: Commercial Press, 1935-1937), Vol. 2, 298.7469-7470.

11 *Huangchao wenxian tongkao*, Vol. 2, 298.7469-7474, 298.7481-7489.

12 *Siku quanshu zongmu* 四庫全書總目(Catalog of the complete collection of the four treasuries), JiYunetal.comp. (Taibei: YiwenPressreprint, 1974), 69. 22a-23a.

ods with data collection and organization. As research pushed forward in the eighteenth century, Asian and Chinese continental geography became a key discipline.[13]

Despite the internal turn of this research away from concern with maritime lands far from China, achievements in geographical knowledge during this period were still evident in military defense and historical and descriptive geography, particularly along the Qing borders with Russia, Zungharia, and Kashgaria in Siberia and Central Asia. In addition, the cultural construction of Mukden (Shenyang 瀋陽) and its environs as the exclusive homeland of the Manchus was achieved in part through the mapping of the area under Jesuit direction. The mapping of Manchuria began circa 1690 in the aftermath of negotiations with the Russians to determine the boundaries of the Amur River in northeast Asia.

Such achievements lent themselves to the cumulation of geographical knowledge. To be sure, the Americas were still depicted as parts of the Asian land mass north of Great Wall in a Chinese world map circa 1743, which was based on Liang Zhou's 梁輈 1593 world map. Moreover, Phillipe Foret 's account of the planning for the Manchu summer capital in Chengde (承德) and for other imperial sites demonstrates how European cartographic technologies could coexist with earlier Chinese geographic practices such as the geomancy informing cartography, landscape architecture, and urban arrangements. The geography of the Qing empire was intertwined with Tibetan Buddhism, and this relationship was an essential component of Manchu expansion into Central Asia. That expansion, as we will see below, also required a substantial investment in state-of-the-art mapping techniques from Europe to delineate accurately the Russo-Chinese border in the eighteenth century.[14]

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13 See Benjamin Elman, "Geographical Research in the Ming-Ch'ing Period," *Monumenta Serica* 35 (1981-1983): 1-18.

14 See Mark Elliot, "The Limits of Tartary: Manchuria in Imperial and National Geographies," JAS 59. 3 (August 2000): 603-646, and Richard Smith, *Chinese Maps: Images of All Under Heaven* (Oxford: Oxford University Press, 1996), 54-59. Compare Phillipe Foret, *Mapping Chengde: The Qing Landscape Enterprise* (Honolulu: University of Hawaii Press, 2000),

II. Cartography, Sino-Russian Relations, and Qing Imperial Interests

Early Manchu rulers recognized the need for better records for land use and taxation. In 1646, a cadastral survey was undertaken, but its geographic inadequacies were recognized. When the Russians appeared in force along the northern frontier in the seventeenth century, the Manchu court and Chinese officials required more accurate geopolitical information to deal with the latest threats to the empire. After the Tungusic chief Gantimur defected from the Qing in 1670 to allegedly Russian territory, the Russians quickly took advantage.

A crisis in Sino-Russian relations ensued from the 1670s to 1690s, when the Manchus learned that the Russians had already built a fortress in 1654 along the Amur River at Nerchinsk in Gantimur's native region. The Kangxi emperor refused any further trade or diplomatic relations with Russia until the deadlock was resolved. Meanwhile, the Russians and Zunghar Mongols both expanded their interests in the northwest while the Qing was preoccupied in the south and southwest during the Revolt of Three Feudatories from 1673 to 1681. Much like late Ming calendar reform, Qing recognition of its geographic needs preceded the European contributions to Chinese cartography. The changing borders threatened the Manchu homeland.[15]

During the Rites Controversy, the Manchu court was embroiled simultaneously in military threats from Zunghars and Russians along the borders of the empire in Central Asia, which introduced new elements into the storm over the Jesuits and their loyalty to the Qing dynasty. For example, when the Russian mission was allowed into Beijing in 1676 to negotiate

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chapter 6.

15 Peter Perdue, "Boundaries, Maps, and Movement: Chinese, Russian, and Mongulian empires in early modern central Eurasia," *International History Review* 20.2(1998): 267-268, and Laura Hostetler, *Qing Colonial Enterprise: Ethnography and Cartography in Early Modern China* (Chicago: University of Chicago Press, 2001), 66-71. Compare Elliot, "The Limits of Tartary," 619-620.

trading agreements and population movements, Ferdinand Verbiest was involved. The lack of a clear boundary in the Amur River area and the ambiguous claims to sovereignty in the area later led to the treaty of Nerchinsk in 1689, negotiated by the French Jesuit Gerbillon, which demarcated the frontiers between the Qing and Russia.

1. Jesuits and Mapping the Qing Empire

The Jesuits and others were commissioned to provide the necessary data that would enable Qing leaders to stem the tide of Russian infiltration into Manchu and Mongolian homelands. The geographical knowledge that accrued during this time was an important addition to earlier information of foreign lands. In the process, the Kangxi court's awareness of the actual geographical divisions of the Sino-Russian frontier slowly came apace of their long-standing knowledge of and interest in Southeast Asia.

Verbiest, however, seems to have secretly provided Russian missions with maps and descriptions of the border region with Siberia, which included the locations of Manchu forces obtained from Russian deserters. Because Russian expansion in Siberia challenged Qing power, the Jesuits thereafter had limited access to the most sensitive frontier areas of the Qing empire when the survey for the Kangxi Atlas was carried out. Territorial claims and dynastic security compelled the Qing court to hire only those Jesuits who did not intend to return to their native lands. The dynasty avoided circulating such information too widely in and outside of China. By 1727, Qing knowledge of the region of Amuria was seen in light of the realities of Russian penetration into Siberia.[16]

The geographical ambitions of the empires of the Qing dynasty, Imperial Russia, and the Mongol Zunghars in Central Asia led to the redrawing of the frontier boundaries between Russia and the Qing in the region and the

16 Mark Mancall, *Russia and China: Their Diplomatic Relations to 1728* (Cambridge: Harvard University Press, 1971), 98-109. See also Peter Perdue, "Boundaries, Maps, and Movement," 269-271, and Laura Hostetler, *Qing Colonial Enterprise*, 77-78. Compare the account in John Witek, ed., *Ferdinand Verbiest (1623-1688): Jesuit Missionary, Scientist, Engineer, and Diplomat* (Nettetal: Steyler verlag, 2001), passim.

crushing of the autonomous state of Zungharia in 1760 by Qing armies. Peter Perdue has noted how eighteenth century Central Asian borders were constructed through three stages: 1) military confrontation; 2) negotiated treaties; and 3) symbolic representation on maps. The Qing dynasty, Zungharia, and Russia each produced important new maps of unprecedented scale and accuracy as political and ideological weapons in their struggle for control of Central Asia.

When Russia and China defined their mutual borders in the treaties of Nerchinsk in 1689 and Kiakhta in 1727, new surveying techniques for cartography were applied by both to the newly defined borders. In addition, new classification systems and ethnographic atlases to control the movements of refugees, nomads, tribes, traders, soldiers, and other mobile groups across the borders were compiled. Both sides used tax and land registers, censuses, border patrols, passports, and visas to keep people from moving freely across the borders. Each also applied seventeenth century European technical knowledge that was transmitted through the Jesuits to survey their new territories.[17]

The Kangxi emperor, like Louis XIV(r. 1643-1715), mapped his entire empire out of strategic concern. The Jesuits produced their first survey of Beijing in 1700, which the emperor checked. Later, he asked for a survey of portions of the Great Wall in 1707. In 1710 further surveys along the Amur river helped mark the strategic bases on the border with Russia. The Kangxi Atlas attempted to systematize the Qing dynasty's knowledge of its imperial territories and rationalize its claims vis-à-vis the Zunghars and Russians.

The Manchu homelands were surveyed between 1709 and 1712 and a complete map of greater Mukden, i.e. "Manchuria" (滿洲), was produced. The text and maps that were included in the 1733 edition of the *Collected Statutes and Precedents of the Great Qing* (大清會典) were concerned with

17 See Perdue, "Boundaries, Maps, and Movement," 263-286, and Laura Hostetler, "Qing Connections to the Early Modern World: Ethnography and Cartography in Eighteenth-Century China," *Modern Asian Studies* 34. 3 (2000): 623-662. See also Mark Elliot, *The Manchu Way: The Eight Banners and Ethnic Identity in Late Imperial China* (Stanford: Stanford University Press, 2001).

military deployments and garrison towns. They were compiled under the auspices of the Ministry of Military Personnel (兵部). The maps that the Jesuits prepared for the Manchu homelands became the starting point for later Japanese and European maps of the region in the eighteenth and nineteenth century.[18]

The atlas and its subsequent Qianlong era revisions shared features that were consistent with contemporary European maps. They left out pictorial elements and drew on astronomical observations to calculate longitude and latitude based on a precise scale. Hostetler interprets such developments in light of Qing evidential studies and the change in research epistemologies that affected scholarly views of geography in the late seventeenth century, a time when government interests increasingly focused on internal military defense and historical and descriptive geography. In the original maps, however, "China" (中國) and the "Qing empire" (清朝) were not coterminous. "China" was presented as one distinct part of the Qing empire, and the Manchus homelands (滿洲) were another. Two other versions of the map from the same surveys, however, were entirely in Chinese with no Manchu script, perhaps to avoid offending Han Chinese cultural sensibilities. These Chinese language maps elided the Manchu view that the maps included distinct administrative and cultural spheres, to which Zungharia and Tibet would later be added.[19]

2. French and Russian Imperial Cartography

France was a leader in cartographic activity under Louis XIV after he appointed Jean-Baptiste Colbert (1619-1683) as minister for home affairs. Colbert made France a center for science and solidified that role in Europe

18 See Walter Fuchs, "Materialen zur Kartographie der Mandju-Zeit, part 1," *Monumenta Serica* 1 (1935-36): 395-396, and Fuchs, "Materialen zur Kartographie der Mandju-Zeit, part 2," *Monumenta Serica* 3 (1938). Compare Elliot, "The Limits of Tartary," 621-632.

19 Perdue, "Boundaries, Maps, and Movement," 274-275, and Hostetler, *Qing Colonial Enterprise*, 17-18, 76. Compare Turnbull, "Cartography and Science in Early Modern Europe: Mapping and the Construction of Knowledge Spaces." *Imago Mundi* 48 (1996), 5-24..

by founding the Parisian Academy of Sciences in 1666. Louis XIV also promulgated topographical surveys for territories based on astronomical observations that were initiated under his chief of astronomy, the Italian Gian Domenico Cassini (1625-1712). While in the employ of Pope Clement IX(r. 1700-1721), Cassini published a series of tables in 1668 based on the eclipses of Jupiter's moons. Colbert invited Cassini to France in 1669 to make astronomical observations crucial to improved navigation and mapping. Because Cassini communicated with the Jesuits in China, he sought such observations globally. Sent to China in 1685, the French Jesuit John Baptist de Fontenay (1643-1710) had been the only well-trained mathematician in his group. He was responsible for astronomical observations and communicated regularly with Cassini in the Paris Academy of Science until his return to Paris in 1703. Fontenay's return effectively marked the end of French Jesuit scientific work in China.[20]

Enlarged in 1676, Cassini's *Ephemerides* (日歷) permitted astronomers to determine the latitude and longitude of the point from which they made their observations. In 1679, France began a national survey relying on Cassini's tables for accurate measurements. The French Academy required observations from around the globe, which in part led to Louis XIV sponsoring the French Jesuits in China under the Missions Etrangéres in 1663. Once mapmaking became a vital component of imperial expansion, the cartographic technology to carry out accurate geodetic surveys spread quickly. France, Russia, and the Qing employed experts regardless of their origins. Colbert had recruited the Italian Cassini, Kangxi employed the French Jesuits, and Russia engaged the Swedish officer Strahlenberg, who was taken prisoner by Russians in 1711, to collect information about Siberia, Mongolia, and neighboring regions.

Peter the Great (r. 1682-1725), like the Kangxi emperor, used maps to measure the growth of the Russian empire and to legitimate its claims.

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20 See Roger Hahn, *The Anatomy of a Scientific Institution: The Paris Academy of Sciences, 1666-1803* (Berkeley: University of California Press, 1971), 66-67, 90, 96-97. Compare Florence C. Hsia, *French Jesuits and the Mission to China: Science, Religion, History* (Chicago: University of Chicago Ph.D. dissertation in History, 1999), 129-132.

In 1698, Peter had already commissioned a survey of his new territories, and new maps for an atlas were completed in 1701, although full surveys of the empire were not formally initiated until 1727 by Catherine the Great. For France, the Qing, and Russia, the requirement of better maps was tied to imperial expansion. New surveying and mapmaking techniques were essential. In the midst of Russian expansion into Siberia the Qing empire more than doubled in size from 1660 to 1760 in a global context of population growth and colonial exploration and expansion.[21]

The Kangxi surveys were quickly completed by 1717, while French surveys took until 1744 to accomplish. The Qianlong revisions of the 1717 survey were finished in 1755, while the second edition of the French survey appeared in 1788. Similarly, the Russian imperial atlas, which followed the French national survey, appeared in 1745. Peter the Great used cartography and his European experts, who were also hired to explore the North Pacific, to put Russia on the map of eighteenth century Europe. The Kangxi Atlas, for instance, had decisively changed European mapmaking when the Jesuit maps first arrived in France in 1725 and the new information was digested in Paris, London, and elsewhere.

Similarly, the latest mapping technology was effective for the Qing in legitimating and consolidating the empire, and became the basis for China's modern territorial claims in the twentieth century. The Kangxi emperor's gift of his survey to Peter in 1721 indicated a desire to apprise Russia of Qing sovereignty and cartographic sophistication. It did not record all the strategic information the Qing had about the northern border areas, however.[22]

More importantly, the Kangxi emperor sought peace with the Russians to free his hand in wars with the Zunghar Mongols in Central Asia. By neutralizing Russia, the Qing court prevented a possible Russo-Zunghar alliance against them. Hence, when the Russians demanded the principle of equality at the Nerchinsk peace negotiations, the Manchus did not allow

21 Hostetler, *Qing Colonial Enterprise*, 71-75. See also Peter Perdue, "Military Mobilization in Seventeenth and Eighteenth-Century China, Russia and Mongolia," *Modern Asian Studies*, 30. 4 (1996): 757-793.

22 Hostetler, *Qing Colonial Enterprise*, 74-79, and Elliot, "The Limits of Tartary," 626.

ceremonial difficulties to interfere with their primary diplomatic task.

The emperor relented on the usual Qing ceremonial claim of imperial superiority when dealing with bordering states. Accordingly, the Treaty of Nerchinsk represented a compromise in which the marking out of the frontier was more favorable to the Manchus, while the Russians kept Nerchinsk. In addition, the Manchus conceded that trade could be initiated by either side, and each could cross the border with passports. Furthermore the problem of the repatriation of fugitives was settled.

As an instrument of diplomacy, the economic concessions made by the Qing government in the 1689 treaty proved their political worth when the leader of Zungharia, Galdan(1644-1697), proposed an alliance with the Russians in 1690. Joint military action against the Manchus was now impossible, however, because the Russians were bound by treaty with the Qing. The Kangxi emperor was left free to eliminate the Zunghar threat, which he did in 1696. Galdan's death in 1697 eliminated the Mongols as a potentially divisive third force in Central Asia.

In 1718, the Russians contemplated full normalization of Sino-Russian relations during Rites Controversy, which was damaging Jesuit and Catholic interests in China. Peter the Great, for example, expelled the Jesuits from Russia in 1719 and tried to install a Russian "bishop" in Beijing in 1722. Russian authorities unsuccessfully kept this effort secret from the Manchus and the Jesuit enemies of the Greek Orthodox Church in Beijing, but Qing suspicions prevented the appointment. Subsequently in 1728, the Zunghar threat against the Manchus in Turkestan and Tibet revived. Again, the Manchus eliminated the threat through the Zunghar wars in the 1750s, which were facilitated by the Treaty of Kiakhta that ended Russian interference. Since 1727, the Kiakhta treaty had established officially supervised trade in Amuria that stabilized the Russian-Qing frontier until the nineteenth century.

The Qianlong reign brought a complete victory over the Zunghars and the incorporation of Ili in the far northwest by the Qing in 1755. Manchu military victories led to Qing overconfidence vis-à-vis the Russians, which generated a ban on trade caravans to Beijing from Russia after 1755. Qing

success in Central Asia in the eighteenth century thus occurred in the context of Russian expansion into Amuria. Through compromise and accommodation, Russian interests in trade and Manchu interests in Central Asia were negotiated. Diplomacy, warfare, and timely mapping of strategic frontiers enabled the Qing dynasty to incorporate major portions of Amuria, Zungharia, and Kashgaria at the expense of the Mongols, Uighurs, Kazaks, Tajiks, and Russians.[23]

III. The Jesuit Role in High Qing Arts, Instruments, and Technology

Before the Napoleonic Wars were resolved in Britain's favor, the Qing court and its literati continued to co-opt certain aspects of European learning and artistic expertise. For example, Jesuits remained as court clockmakers and geometers, and a Jesuit, usually Swiss, was always in charge of the imperial clock collection in the eighteenth century. When compared to the industrializing tendencies in Britain and France, the imperial workshops in Qing China, like the Academy of Mathematics under the Kangxi emperor, were never breakthroughs to European-style science and technology.

Such workshops were, however, evidence for the important role of Jesuits working with Chinese artisans in manufacturing clocks, porcelain, glass, and building pavilions and gardens during the late empire. Interestingly, when the Macartney mission presented clocks and watches to the court to demonstrate British inventiveness, the Qianlong emperor was not particularly impressed and rejected any official trade with Britain. His haughty imperial tone belied his extensive collecting and reproducing European manufactures and clockwork at home.[24]

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23 Mancall, *Russia and China*, 149-159, 209-210. The translation of the treaty is on 280-283. See also Eric Widmer, *The Russian Ecclesiastical Mission in Peking During the Eighteenth Century* (Cambridge: Harvard University East Asian Research Center, 1976), 45-58, 174-178.

24 Catherine Pagani, "*Eastern Magnificence & European Ingenuity*": *Clocks of Late Imperial China* (Ann Arbor: University of Michigan Press, 2001), 39-57, 70-74. On earlier clockwork

1. Clock Making in the Kangxi Era

The French and Swiss Jesuits' expertise in mathematics, astronomy, cartography, and clock making was connected to the unprecedented degree of precision in their time and space measurements. When the Kangxi emperor commissioned the Jesuits to survey the entire empire between 1708 and 1717, the required mapping was accomplished in collaboration with official Chinese astronomers and Manchu officials. Chinese clockmakers were trained because the Kangxi emperor also thought clock making skills were worth appropriating. Chinese who worked under Jesuits were expected eventually to make native clocks.[25]

According to Catherine Pagani, mechanical clocks in early modern Europe were a metaphor for God's maintenance of the universe. In an age when a mechanistic view of nature was emerging, Europeans believed that the mastery of clock mechanics would lead to better understanding of God's design of the world. The Jesuits accepted this view, but they also recognized that when mechanical clocks were presented to potentates at home and abroad, this act of gift giving gained them access to high places in the papal court as well as in the Chinese empire. Their skills as architects and glassmakers paralleled their careers as calendricists and clock makers in late imperial China.

Matteo Ricci (1552-1610) believed, for example, that he had gained admission to the Wanli court by presenting a clock and repeating watch to the Ming emperor, a tactic which followed established European gift-giving practices. When Johann Terrenz Schreck (1576-1630) and Wang Zheng 王徵 (1571-1644) prepared their 1627 translation entitled *Diagrams and Explanations of the Marvelous Devices of the Far West* (遠西奇器圖說錄最),

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in China, see SCC, Vol. 4, 220-266.

25 Catherine Jami, "Western Devices for Measuring Time and Space: Clocks and Euclidian Geometry in Late Ming and Ch'ing China," in Chun-chieh Huang and Erik Zürcher, eds., *Time and Space in Chinese Culture* (Leiden: E. J. Brill, 1995), 169-200. See also Nicolas Standaert, ed., *Handbook of Christianity in China, Vol. One: 635-1800*(Leiden; Boston: Brill, 2001-), 840-850.

it represented the first work in Chinese that provided information about European escapement techniques for delivering power at regular intervals to move the train of wheelwork inside a timepiece. Subsequently, the Wanli emperor had his eunuchs work with the Jesuits to master the art of repairing the clocks he had been presented.

In late seventeenth century, the Kangxi emperor established a number of workshops that manufactured luxury items under the auspices of the Office of Manufacture in the imperial household. These were modeled after the French Academy. Mentioned in palace documents of 1689 and 1692, the workshops were at the outset staffed by Jesuits and workmen from Guangdong province. After the imperial workshops were formally established in 1693, there may have been as many as thirty-one shops. Most clocks in the eighteenth century were completed in shops inside the Forbidden City. An Office of Clock Manufacture was subsequently created in 1723, which lasted until 1879 when the last list of clocks in the court was compiled.[26]

Three major sites were operating in 1756 under the Office of Manufacture within the Imperial Household Department. There, clockmakers, painters, and engravers worked in the decorative arts using enamels and glass for the clocks. The Lofty Pavilion gardens (圓明園) also served as venue for clock-making. In 1752, for instance, Amiot mentioned that the Jesuits prepared a hemicyclical mechanical theater clock with three scenes, which was built for the empress dowager's sixtieth birthday and remained in the Lofty Pavilion. Manchu and Chinese interest in elaborate mechanical clockwork, as in Europe, clearly represented the linkage of imperial power and prestige.[27]

Five European horologists were working in Beijing in 1701 during the Kangxi reign. Under the Qianlong emperor, eleven Jesuits built clocks in the imperial workshops. By 1800, Chinese artisans were proficient enough

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26 Catherine Pagani, "Eastern Magnificence," 26-57, 181-184, and Craig Clunas, "Ming and Qing Ivories: Useful and Ornamental Pieces," in William Watson, ed., *Chinese Ivories from the Shang to the Qing* (London: Oriental Ceramic Society, British Museum Publications, 1984), 122.

27 Pagani, "Eastern Magnificence," 58-98.

to make mechanical clocks themselves, and the role of missionaries in the production process was limited. The end of the Jesuit order was also an important reason. Outside of Beijing, for instance, imperial clock making workshops were also established in Suzhou and Hangzhou.

The native industry for clocks served as an effective form of tribute among Qing officials. Such modest levels of industrial production by native artisans were monopolized by the court and its literati elites. Production in the provinces was controlled by Chinese merchant guilds. The popularity of mechanical watches among Chinese elites mirrored imperial taste in the eighteenth century. Mechanical clocks were mentioned in novels such as *Dream of the Red Chamber* (紅樓夢), where owning one reinforced the high status of the Jia 賈family.[28]

2. Imperial Factories for Glassware

Despite the damage their influence suffered in the Manchu court after the Rites Controversy, The French Jesuits remained heavily involved in the glass workshop that the Kangxi emperor had established in 1696 as one of his palace workshops. The German Father Kilian Stumpf (1655-1720) in particular worked with the French Jesuits to produce decorative glass under imperial auspices. To please the emperor the Jesuits arranged to have two glassworkers sent to Beijing in 1699 to work in the imperial workshop.[29]

The Beijing workshop was producing high-quality glassware from the beginning of the eighteenth century. Decorative snuff bottles were fabricated in a wide variety of colors and shapes. The emperor presented such glassware as gifts to high officials on his southern tour to the Yangzi delta in 1705, for instance. He also presented the papal legate de Tournon with an enameled glass snuff bottle at the outset of what proved to be a disastrous series of meetings in 1706 to discuss the Rites controversy. Matteo Ripa (1682-1745), an Italian Jesuit who arrived in China in 1710, noted that by 1715 the glass workshop consisted of several furnaces for glassmaking,

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28 Pagani, "Eastern Magnificence," 76-78, 91-93.

29 Emily Curtis, "Plan of the Emperor's Glassworks," *Arts Asiatiques*56 (Paris, 2001): 81-90.

which required a large number of skilled craftsmen under Stumpf's supervision. In 1719, Jean-Bapitiste Gravereau, a French Jesuit expert in enamel, arrived in Beijing. The enameled glassware produced in the workshop was of high enough quality that in 1721 the Kangxi emperor sent the Pope two cases of enamel ware, in addition to 136 pieces of Beijing glass.[30]

After the Yongzheng emperor's anti-Jesuit policies took effect, the imperial workshop, like the Kangxi era Academy of Mathematics (算學館), increasingly relied on native glassmaking talent, particularly after Stumpf died in 1720. The workshop also was encouraged to manufacture enamel colors independently of the Jesuits. In addition, enamel colors were sent to the imperial pottery kilns in Jingdezhen (景德鎮), where new, enamel-decorated porcelains appeared for the first time. The overglaze blue of the Kangxi era had been introduced to Jingdezhen in 1700, and under the Yongzheng reign a translucent pink enamel made from colloidal gold was used in porcelain. The opaque pink glaze with specks of metallic gold developed by the imperial workshop drew on a recipe for ruby glass in a clear blue matrix. The source for the ruby glass derived from an ancient Venetian formula, rediscovered and developed in Germany.[31]

Despite his animosity towards Christianity and the Jesuits, the Yongzheng emperor established a branch of the glass workshop at the

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30 Peter Lam, "The Glasswork of the Qing Imperial Household Department," in *Elegance and Radiance: Grandeur in Qing Glass, The Arthur K. F. Lee Collection* (Hong Kong: Art Museum, Chinese University of Hong Kong, 2000), 46-47, and Yang Boda, "Qingdai boli gaishu"清代玻璃概述 (Overview of Qing dynasty glassware), *Gugong bowuyuan yuankan*故宮博物院院刊1983.4 (1983): 13-16. See also Yang Boda, "An Account of Qing Dynasty Glassmaking," in *Scientific Research in Early Chinese Glass* (Corning, NY: The Corning Museum of Glass, 1991), 144.

31 Zhang Rong, "Imperial Glass of the Yongzheng Reign," in *Elegance and Radiance: Grandeur in Qing Glass, The Arthur K. F. Lee Collection*, 64. See also Rosemary Scott, "Eighteenth Century Overglaze Enamels: The Influence of Technological Development on Painting Style," in Rosemary Scott and Craham Hutt ed. *Colloquies on Art & Archaeology in Asia* no. 14: *Style in the Easter Asian tradition* (London: Percival David Foundation of Chinese Art, 1987), 156-158.

workshops in the Lofty Pavilion gardens in the northern suburbs of Beijing , where since 1712-1713 astronomical and mathematical work also carried out. Production also continued at the Jesuit glass workshop into the Qianlong era, when two additional Jesuits joined the imperial glass workshops in 1740. Glass production reached its high point when the Jesuits became involved in constructing European-style palaces and gardens for the Lofty Pavilion gardens in the 1750s.

European-style glassware was produced for display in the elaborate buildings that the Qianlong emperor asked Giuseppe Castiglione (1688-1766) and others to design for him. Castiglione's designs for Gabriel-Leonard de Brossard's carved glass and enamels were also prominently displayed in the palaces of the Forbidden City (故宫). Chinese decorative themes were connected with European illustrative skills for shading and perspective to adorn glassware. By 1766, the Qianlong emperor had turned the Lofty Pavilion gardens into a treasure house of gardens, pavilions, paintings, glassware, porcelains, and furniture, whose artistic merits and technical prowess were of the highest standards.[32]

3.Jesuits and Garden Architecture

Due to the Qianlong emperor's patronage, the Jesuits found new life in the Qing cultural world of the 1750s through their expertise in painting, designing, and building the lavish European-style palaces and interiors that the emperor sought. Initially impressed with the grandeur of European style fountains, the emperor asked Castiglione to draw up plans for such fountains in the Lofty Pavilion gardens. Castiglione in turn sought the help of Michel Benoist, who had arrived in China in 1744 and later presented the court with an accurate account of Copernican cosmology. Because Benoist

32 Zhang Rong, "Imperial Glass of the Yongzheng Reign," 63. See also Peter Lam, *Elegant Vessels for the Lofty Pavilion: The Zande Lou Gift of Porcelain with Studio Marks* (Hong Kong: Art Gallery, Chinese University of Hong Kong, 1993), 33-36. Compare Emily Curtis, "Glass for the Qing Court: The Jesuit Workshop," paper presented at the colloquium on "Art Brokering for China: The Missionary Connection," sponsored by the UCLA Center for Chinese Studies in conjunction with the Southern California China Colloquium, May 4, 2002.

was knowledgeable in mathematics and hydraulics, as many Jesuits were, he was able to present the emperor with a model fountain, which the court quickly authorized Castiglione to build alongside the Baroque style palatial buildings.[33]

The garden designers and builders were entirely Jesuits, with Castiglione playing the most prominent role. They were well prepared for their task in Beijing because in contemporary Rome the popes had glorified themselves and the Church via an ambitious scale of building palaces, piazzas, and fountains throughout the old city, which had been supervised by the clergy. The mid-eighteenth century was also a time when the impact of chinoiserie style architecture, gardens, and lakes on European rulers and aristocrats led to the construction in Europe of Chinese style rooms, gardens and pagodas, such as the 1762 garden and pavilion in Wales designed by the architect Sir William Chambers for the Princess Dowager Augusta.[34]

When the first pavilion was completed in 1747, the Qianlong emperor indicated his pleasure, according to Benoist. Located on sixty-five acres, the European section (西洋樓) of the Lofty Pavilion gardens was 750 meters long and 70 meters wide when completed and stood at the northern end of the Long Spring Garden (長春園) inside the Lofty Pavilion's massive grounds. The second phase of the European section inside the Lofty Pavilion took another eight years to complete.[35]

A three-story palatial building designed by the Italian Jesuit architect Ferinando Moggi was known as the Belvedere (方外觀) when completed in 1759. Built in a crescent shape evoking Islam, it had marble balustrades enclosed by a moat. After entering from the bronze outdoors stairway that

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33 See the special publication of *Yuanming yuan* 圓明園 (Lofty Pavilion) 1 (November 1981).

34 Richard Rudolph, "Early China and the West: Fertilization and Fetalization," in Rudolph and Schuyler Cammann, *China and the West: Culture and Commerce* (Los Angeles: Clark Library, 1977), 4-5.

35 See Wong Young-tsu, *A Paradise Lost: The Imperial Garden Yuanming Yuan* (Honolulu: University of Hawaii Press, 2001), 59-65, and the drawings included in Régine Thiriez, "The Qianlong Emperor's European Palaces," in *The Delights of Harmony: The European Palaces of the Yuanmingyuan & the Jesuits at the 18th Century Court of Beijing* (Worcester, MA: Cantor Art Gallery, College of Holy Cross, 1994).

rose up to the second floor, one encountered two tall stone tablets with Arabic inscriptions. The front door resembled that at St. Andrea Al Quirinale in Rome and faced a marble bridge with flamboyant balustrades across from a moat that lead to a smaller garden.

To the east a thirty-six room pavilion was named the Sea Calming Hall (海宴堂) when completed in 1781. The largest structure built in the European section, it was likely modeled on Court of Honor at Versailles. It housed a reservoir with goldfish under a glass ceiling. A room on each side contained hydraulic machines to pump the water in the reservoir and feed the outside fountains and cascades. Nearby stood a triple gateway each with triumphal arches that resembled the Triumphal Arch in Paris.[36]

The pavilions, fountains, and arches designed by the Jesuits comprised about one-fifth of the Lofty Pavilion. For such a large-scale project, they were required to supervise many Chinese artisans, builders, and masons, whose architectural talents were indispensable for constructing the European section using Chinese materials and tools. Hence, the Baroque models that the Jesuits designed melded with Renaissance, French, and Rococo styles that the imperial laborers also reproduced. Elements of Chinese garden architecture, such as the inclusion of "Lake Tai stones" (太湖石頭) and bamboo pavilions, were added to the mix of buildings in the European section, which included roof tiles in native yellow, green, and blue colors. [37]

Overall, the Lofty Pavilion represented a syncretism of architectural styles and tastes that the Manchu court favored as part of their efforts to create a universal vision of their power first in Asia and then in the world. The most representative building of this syncretic style was the small Belvedere, which combined the design of a Florentine building with a classic double Chinese roof. The interior designs for the pavilions were also inspired by European models. Glass windows, wood plank floors, handrails, flower terraces overlooking lawns, mechanical clocks, hanging lamps, and

36 See Victoria Siu, "Castiglione and the Yuanming Yuan Collections," *Orientations* 19 (1988, Hong Kong): 72-79.

37 Wong Young-tsu, *A Paradise Lost*, 59.

oil paintings. Even Gobelins tapestries of French beauties presented by Louis XV (r. 1723-1774) were placed throughout the European section. Large nude figures were not included, however. Chinese garden elements outside and traditional scroll paintings inside added to an ambience of Manchu pretensions as global style setters.[38]

IV. Final Comments

The leaders of the 1793 Macartney mission defined their historical role vis-à-vis their Jesuit predecessors by presenting Great Britain, and thus themselves, to the Manchu court and Chinese literati as the mechanical leaders of Europe and as enthusiastic teachers of their new scientific knowledge. Lord Macartney believed that the gifts that he had brought, chief among them a solar planetarium synchronized by "the most ingenious mechanism that had ever been constructed in Europe," were more sophisticated than the armillary spheres, mechanical clocks, and telescopes that had previously been introduced by the Jesuits. He also thought that such gifts would convince the Qianlong emperor of Britain's dominance in science and technology.[39]

Furthermore, when members of the Macartney mission visited the imperial glass making workshop in 1793-1794, one of them noted that the site was now neglected. After Brossard's death in 1758, production at the Jesuit workshop had declined. Subsequently in 1827 all missionary property was confiscated, and in 1860 the Lofty Pavilion gardens were destroyed by Lord Elgin's troops who had taken Beijing during the second Opium War and forced the imperial court to flee to their summer retreat in Chengde. The planetarium Macartney delivered had attracted some interest, but his obser-

38 See George Loehr, "The Sinicization of Missionary Artists and Their Works at the Manchu Court During the Eighteenth Century", *Cahiers D'histoire Mondiale* 8 (1963): 795-803. Compare Phillipe Foret, *Mapping Chengde*, 15-23. See also Pamela Kyle Crossley, *A Translucent Mirror: History and Identity in Qing Imperial Ideology* (Berkeley: University of California Press, 1999).

39 John Barrow, *Travels in China* (London: T. Cadell and W. Davies, 1804), 110.

vation of Chinese "ignorance" misleadingly convinced him that diplomatic success would naturally follow once British cultural superiority and scientific expertise were transmitted to the emperor.[40]

The Macartney mission may have been a harbinger of things to come, but neither Lord Macartney nor the Qianlong emperor could foresee what the industrial revolution in England would yield in terms of British military superiority and Protestant evangelism in nineteenth century China. We should not read the events of the first and second Opium Wars back into the eighteenth century. Qianlong arrogance encoded in the emperor's infamous 1793 edict to King George III (r. 1760-1820), and British imperialism were inseparable. Qing China did not yet require "ingenious objects" or "manufactures" from England anymore than India did before Manchester mills dislodged the Indian cottage industry. Indeed, the Jesuits had already provided the court and literati with ingenious clocks, fountains, palaces, and glass works.

Moreover, the Chinese were masters of porcelain while in the late eighteenth century Europeans avidly sought the manufacturing secret for making it but were unsuccessful until the late Qing. Englishmen such as Francis Bacon had at one time thought that porcelain developed from an "artificial cement" buried in the earth for a long time, not unlike Chinese views of the formation of amber (琥珀). John Donne considered buried clay the source for porcelain. Song Yingxing's 宋應星 (1587-1666) 1637 *Heavenly Crafts for Opening Things up to Practical Use* (天工開物) had included a section on pottery-making, but because the work described procedures for government monopolies the work was not available publicly, except for portions reproduced in the early eighteenth century *Synthesis of Books and Illustrations Past and Present* (古今圖書集成) encyclopedia.[41]

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40 George Macartney, *An Embassy to China*, 299. See also James Hevia, "Looting Beijing: 1860, 1900," in Lydia Liu, ed., *Tokens of Exchange: The Problem of Translation in Global Circulations* (Durham: Duke University Press, 1999), 192-199.

41 See Lydia Liu, "Robinson Crusoe's Earthenware Pot," *Critical Inquiry* 25 (Summer 1999); 749-750. See also *Eminent Chinese of the Ch'ing Period*, Hummel, Arthur, ed. (Reprint. Taibei: Chengwen Bookstore, 1972), 691.

The international trade in porcelain from the Jingdezhen pottery kilns, for example, was directed by the tens of thousands of pieces through Guangzhou to Southeast Asia and Europe. In early modern Europe, Chinese porcelain was called "china." Queen Mary II of Britain, for instance, had a porcelain room designed by the Dutch decorator Daniel Marot. Another such room was restored in 1688 in the Oranienburg Palace by Frederick III, elector of Brandenburg and Prussia, which consisted of a salon decorated with cabinets and pyramids of Chinese porcelain. The king of Saxony, Augustus the Strong, had over twelve hundred *blanc de Chine* wares made in Dehua (德化), Fujian. White-glazed porcelain was more fragile due to the crispy clay used in Fujian. Until their popularity waned in the eighteenth century, *blanc-de-Chine* wares were also collected at the English royal palace at Hampton Court and show up in the 1688 catalog of holdings in the Cecil family's Burghley House.[42]

Aeneas Anderson, who accompanied Lord Macartney on his 1793 mission, wrote: "There are no porcelain shops in the entire world which can compare in size, richness or delivery with those in Canton." As imperial patronage lessened in the nineteenth century, however, the porcelain industry declined significantly, and Wedgwood in England and Japanese potters replaced Jingdezhen as the best known pottery kilns in the world. The post-industrial material needs of China would follow on the heels of an illegal opium trade that artificially created a low cost commodity grown in a British colony, to which millions of Chinese became addicted. In the process, China, like India, was "de-industrialized."[43]

（責任編輯：張　遠　校對：翁健鐘　江瑋平）

42 See John Ayers and Rose Kerr, *Blanc De Chine: Porcelain from Dehua* (Chicago: Art Media Resources, 2002), passim.

43 Michel Beurdeley and Guy Raindre, *Qing Porcelain* (New York: Rizzoli, 1986), 35-37, 143-144, 192-210. See also Ssu-yü Teng and John Fairbank, eds., *China's Response to the West: A Documentary Survey, 1839-1923* (Cambridge: Harvard University Press, 1979), 19-20. Compare James Hevia, *Cherishing Men From Afar: Qing Guest Ritual and the Macartney Embassy of 1793* (Durham: Duke University Press, 1995), 225-248, and Liu, "Robinson Crusoe's Earthenware Pot," 749-750.

The Jesuit Role as “Experts” in High Qing Cartography and Technology

Benjamin A. Elman*

提　要

在明清之際的思想文化上，耶穌會士擔任何等角色，先前的論述一般未能做出適切的評價。許多案例顯示，耶穌會士與當時日新月異的士人之學關連不大。以醫學領域為例，在十九世紀之前，少有儒醫感受到近代歐洲蓋倫式（Galenic）醫學的威脅。另一方面，康熙年間（1661~1722）朝野之所以對數學大感興趣，與耶穌會士將借根方、三角學與對數傳入中國關係密切。自雍正皇帝（1722~1735 在位）施行某種程度的「閉關政策」以來，在十八世紀末葉到十九世紀初之間，中國學者主要致力於全面性的考索傳統數學，並與西方數學比勘對照。

十八世紀初，為了中國境內天主教徒可否祀孔祭祖，清廷與羅馬教皇相持不下。雖經此一頓挫，耶穌會士仍然膺任欽天監的重要「專家」，以及宮廷造辦處監造者之職。明清之際來華的湯若望（Adam Schall, 1592~1666）與南懷仁（Ferdinand Verbiest, 1623~1688）在向士人菁英傳教的過程中，不僅倚重數學知識的紹介，也奉命制作許多器械與武器。十八世紀在中國傳教的耶穌會士，其技術專長包括翻譯西方文獻與地圖，以及引介測量方法，乃至製造大砲、滑輪系統、日晷、望遠鏡、水泵、樂器、時鐘與其它機械器具。這些耶穌會士在歐洲的論敵則指控他們目的不在服事教會，而是為了私利而效力於當地統治者。

關鍵詞: 耶穌會士　地理　專家　玻璃（儀器）制作　鐘錶　建築學

* Professor of East Asian Studies and History, Princeton University.