CHINA AND THE WORLD HISTORY OF SCIENCE, 1450–1770

By Benjamin Elman

HISTORIANS HAVE PORTRAYED the period from 1450 to 1770 mainly through European frames of reference, even when their accounts stress comparative themes. Because the emergence of capitalism, political revolution, and modern science in the industrializing portions of Western Europe represents their central story, they have not probed how interactions since 1500 between Asia and early modern Europeans evolved from the Asian perspective. Most modern portraits of the rise of science, for example, usually represent variations of a story of Western European scientific "success," and, by comparison, non-Western "failure."[1]

For over a century, Europeans have heralded the success of Western science and assumed the failure of science elsewhere.[2] Since 1954, Joseph Needham had stressed the unique rise of modern science in Europe, but at the same time acknowledged the achievements in traditional Chinese science and technology until 1600. In the decades since Needham answered his provocative question, "why didn't the premodern Chinese develop modern science?"[3] we have increasingly acknowledged that our focus on the "failure" of Chinese science to develop into modern science is heuristically interesting but historiographically misguided. We are now forced to reassess how the global history of science should be rewritten.[4]

Europeans thought of themselves as technologically superior to others after 1500, but the Chinese never agreed with this perspective until they observed firsthand the effects of the industrial revolution on nineteenth-century battlefields in East Asia. In contrast to China, where natives remained in political control, the British colonial regime set the agenda for natural studies in South Asia. British imperial power after 1700 dictated the terms of social, cultural, and political interaction between natives and Westerners in India. New knowledge was in turn ordered and classified according to the standards of authoritative British scientific practice. Colonial forms of knowledge translated into reports, statistical records, histories, gazetteers, legal codes, and encyclopedias that induced elites in India to become part of Britain's project of political and cultural control. Colonized natives acquired enough practical experience to understand how to acquire, study, and interpret natural knowledge.[5]

Gyan Prakash, for example, describes how the British regime staged science in India via museums, exhibitions, and governmental projects. Such staging presented science as a universal sign of modernity, which augmented colonial rule in the nineteenth century by educating native elites according to the acceptable forms of scientific knowledge and natural history. Western-educated elites portrayed modern science and technology as a preferred value system and as useful technology, which could enrich India's indigenous traditions. Indian elites also renegotiated the terms of their acceptance of the British regime of science and technology. They created a hybrid discourse of science and nation, which claimed the ancient Hindu *Vedas* as the roots of science and modernist forms. Colonial power provided the intellectual space within which Indian intellectuals appropriated science and refashioned their own traditions in light of the ideals of modern science—despite the presence of British colonial power.[6]

Armillary sphere, 1669, by Ferdinand Verbiest a Flemish Jesuit missionary in China (Chinese name Nan Huairen, 1623–1688). Silver-gilt and sandalwood.
The Palace Museum, Beijing. Image source:http://www.threeemperors.org.uk/index.php?pid=10

Fascinating as the colonial case of India is, early modern Chinese contested European claims to scientific and religious superiority at every stage of their interaction after the 1580s. One reason we have detailed accounts of conditions in Chinese prisons in the sixteenth and seventeenth centuries, for instance, is that aggressive religious proselytizers from the Augustinian, Dominican, Franciscan, and Jesuit orders prepared the accounts after the Ming dynasty (1368–1644) locked up some of the clerics. In fact, Chinese and Manchus during the Qing dynasty (1644–1911) induced Jesuit experts to work as imperial minions in the government bureaucracy to augment their own projects of political and cultural control, using the latest mathematical, astronomical, military, and surveying techniques.[7] It would be a historiographical mistake to underestimate Chinese efforts to master the Western learning of the Jesuits in the sixteenth, seventeenth, and eighteenth centuries.

Most Western accounts have described how British imperial expansion collided with a sinocentric Qing state unsympathetic with scientific knowledge. But this view should be amended. We should not read the Qianlong emperor's (r. 1736–1795) famous 1793 letter to George III gainsaying Western gadgets as the statement of a Manchu dynasty completely out of touch with reality. The emperor did not categorically reject Western technology. His court simply contested the originality of the astronomical instruments—a replica of the solar system, for example—that the Macartney mission brought to China. Qianlong, on the other hand, showed great interest in the model warship equipped with cannon that Macartney presented. Unaware of the industrial revolution in Europe, the emperor had widely employed European Jesuits as astronomers, architects, and cannon-makers.

Now that the Qing calendar functioned properly with Jesuit help, the emperor was not inclined to think Macartney's planetarium so fabulous. Later emperors who faced irresistible English military firepower in the aftermath of the Opium War (1839–1842) were dealing with a different set of technological circumstances. Chinese had incorporated algebra and geometry and made natural studies a part of classical studies, but the continued development of science and technology in Europe would require the Chinese to depend on the modern sciences introduced by Protestant missionaries in the new historical conditions of the post-Napoleonic age in Europe after 1815.

Why have we undervalued Chinese achievements before 1800? Principally because during the Sino-Japanese War from 1894 to 1895, the Japanese army and navy decisively defeated the armed forces of the Manchu Qing dynasty. Since then, Chinese and Japanese patriots and scholars have assumed that Meiji Japan (1868–1911) was vastly superior to Qing China in modern science and technology prior to 1894. Actually, prior to the war, many contemporary observers thought the Qing army and navy were superior, even if only in sheer numbers. After 1895, each side rewrote their histories to validate triumphant Japan or lament the defeated Qing. For Chinese and Manchus, the Sino-Japanese War turned the Qing era of Self-Strengthening Reforms from 1865 to 1895 into an alleged scientific and technological catastrophe.[8]

Naval Wars in Chinese History

One of the ironies of the Qing misfortune in 1895 was that since the Song dynasty (960–1280), China had at times supported a substantial navy, which the Mongols used to invade Japan in 1274 and 1281, and to attack Java. Subsequently, the Ming dynasty (1368–1644) navy under Admiral Zheng He (1371–1433) carried out several enormous excursions into Southeast Asia and the Indian Ocean from 1403 to 1434, which ended when the court scrapped the navy in the 1460s to prepare for possible land wars in the northwest against the resurgent Oirat Mongols.[9]

A coastal navy equipped with cannon and firearms had defended the China coast from Japanese pirates in the mid-sixteenth century, initially in vain but with eventual success. Chinese naval power further revived when the Ming helped Korea to halt Toyotomi Hideyoshi's (1536–1598) massive invasions of 1592 and 1598. Subsequently, Ming loyalists defeated the Qing dynasty in their initial major naval and land battles along the Fujian coast. The naval revival lasted only until the 1680s, however, when Qing naval forces finally annexed Taiwan. Thereafter, Chinese still developed new types of sailing vessels, such as the Zhejiang junks first built in 1699 for the Ningbo-Nagasaki trade between Japan and China, which lasted into the eighteenth century despite Japan's alleged but incomplete closed door policies.

The Qing court in the 1860s and we today might have heralded the revival of the Qing navy after the Opium wars as a return to the brighter days of the early fifteenth, mid-sixteenth, and seventeenth centuries. Instead, the late Qing navy was ridiculed after 1895. Anti-Manchu patriots pointed to the Zheng He fleets as sign of China's past greatness and current Manchu weakness. Moreover, the superiority of Japan in modern technology and science was assumed after the Sino-Japanese War. Indeed, the Manchu regime lost its political credibility among its Chinese majority because of the war. The Japanese navy dominated Pacific waters until 1945. The possible continuity between the military strength of the Ming and early Qing naval fleets and the late Qing navy became inconceivable.

. . . we as teachers also need to tell that quieter story of longstanding Chinese interests in the natural world, medicine, commerce, the arts and crafts, all of which set the stage for interaction with European science, technology, and medicine after 1600.

No amount of sophistry can turn the Qing debacle in 1895 into a hollow victory. Past accounts of China's failures in science and dynastic losses on modern military battlefields are instructive, but their rhetoric about that violence has usurped the actual destructive events—long since past—that placed China at the mercy of the West and Meiji Japan from the 1890s. Another story lies beneath the cultural narrative of scientific, technological, and military failure after 1895. It will never replace the triumphal story of the march of Western and Japanese imperialism via science, technology, and empire-building. But we as teachers also need to tell that quieter story of longstanding Chinese interests in the natural world, medicine, commerce, the arts and crafts, all of which set the stage for interaction with European science, technology, and medicine after 1600.

Late Ming Classicism in the Context of Commercial Expansion

Ming officials were concerned about maintaining the late Ming agrarian economy. It drew its strength from the productivity of an integrated river-canal-lake system and land-commodity-labor taxes collected from private farms in over 1,300 counties where about 90 percent of China's population of approximately 150 million people lived in 1600. Beginning in 1381, the government classified the entire population into social and economic categories to determine taxes and measure access to civil and military examinations. Revised in 1391, this massive undertaking measured the economic resources under Ming control, equalizing the distribution of the land tax (paid in kind), and obtaining fair labor services from all households.

Echoing the ancient classical models in the *Rituals of Zhou*, a text that imperial reformers since antiquity appealed to for contemporary guidance, the classifications of households into farmers, commoners, military men, artisans, and merchants reflected the status of each family in early Ming society and how much labor service they had to provide. These tasks were organized according to village-family units of 110 households per community. A merchant household was expected to supply merchandise or goods on demand; a military family had to provide at least two soldiers for service; an artisan household provided one worker for imperial workshops. The wide gap between the theory and practice of Ming tax collection, however, greatly diminished government control of the economy by the sixteenth century. Regional markets gradually turned to silver currency for large transactions, which were out of the direct control of the government, to pay for land and labor taxes.

Geared to village life circa 1400, the moral economy of the Ming tax system by 1600 became increasingly obsolete as population rose from 65 to 150 million and the economy became more

To gain the trust of the throne and its literati, Matteo Ricci (1552–1610) and his followers prioritized natural studies and mathematical astronomy during the late Ming and early Qing precisely because they recognized that literati and emperors were interested in such fields.

Matteo Ricci and Xu Guangqi.
Image source: http://en.wikipedia.org/wiki/Image:Ricci1.jpg

commercialized. The Ming economy was transformed by an agrarian revolution during which cotton displaced rice production in southern coastal provinces. The influx of New World silver further monetized the sixteenth century Ming economy. The Chinese economy was further monetized by the importation of Japanese silver in the early seventeenth century. Thus, the Chinese faced a global marketplace, in contrast to earlier more regional concerns. Even by the 1570s, the Ming government had bowed to the inevitable and through tax reforms commuted the land tax and service labor systems into a single monetary payment in silver.[10]

As China's population grew, the reach of the relatively static imperial bureaucracy of 1,350 county magistrates declined. Similarly, anxious Ming literati wondered if the classical orthodoxy could still represent universal principles of knowledge at a time when domestic goods and things were converted into objects of wealth purchased with imported silver. Ming literati such as Yuan Huang (1533–1606) worked out the tensions between morality and affluence by creating a new moral calculus for measuring private wealth to keep track of good and bad deeds in ledgers of merit and demerit.[11]

Although late Ming literati still placed human understanding within a classical theory of knowledge, the quantity and exchange velocity of the marketplace had multiplied exponentially. Ming elites were living through a decisive shift away from the traditional ideals of sagehood, morality, and frugality. Within an inter-regional market economy of exceptional scope and magnitude, gentry and merchant elites transmuted the impartial investigation of things for moral cultivation into the consumption of objects for emotional health and satisfaction. Ming painters presented the contemporary connoisseurship of antiquities, for example, as a genre known as "Broadly Examining Antiquities" (*Bogu tu*). The paintings valorized the literatus as a collector of exquisite things.

Late Ming antiquarianism in particular drew its strength from the economic prosperity that pervaded the Yangzi delta. There and elsewhere, merchants and literati used their increased financial resources to compete for status through conspicuous consumption. Merchants and literati on their travels searched for ancient works of art, early manuscripts, rare editions, and magnificent ceramics. They paid extravagant sums when they found what they wanted. The rise in value of ancient arts and crafts also touched off increased production of imitations, fakes, and forgeries of ancient bronzes, jades, and ceramics. Late Ming antiquarians with their fixation on possessing things challenged the principled ideals of both orthodox learning and revisionism.

Pre-Modern and Modern Science

When Europeans reached China during the age of exploration, their highest learning, known as *scientia,* was not natural science. Natural philosophy, not natural science, was a field of higher learning. *Science* was a medieval French term synonymous with accurate and systematized knowledge. When Latinized, the word became *scientia* and represented among scholastics and early modern European elites the specialized branches of Aristotelian moral and natural philosophy. Included in the Scholastic regime for learning were the seven sciences of medieval learning: grammar, logic, rhetoric, arithmetic, music, geometry, and astronomy. Comparable to the classical ideal of the six arts in ancient China (rites, music, archery, charioteering, calligraphy, and mathematics), these seven liberal arts served in Roman education as preparation for more specialized training in philosophy, medicine, or law.

After Scholastics reconciled the Muslim harvest of classical learning with Christian theology, the preferred order of Aristotelian learning for Renaissance scholars and bookmen became: 1) logic, 2) mathematics, 3) natural science, 4) moral philosophy, and 5) metaphysics. This regime was reproduced in the *Ratio Studiorum* at Jesuit colleges in Western Europe. The Jesuits transmitted Aristotelian cosmology, physics, and meteorology through their Scholastic theory of knowledge.[12]

Late imperial Chinese also prioritized mathematical studies for their pre-modern exact sciences, which informed Chinese astronomy, geography, cartography, and alchemy in different ways. Literati also applied the naturalistic concepts of yin and yang and the five evolutive phases (*wuxing*) to elucidate the spontaneous (*ziran*) changes in the stuff of the world (*qi*). Rational and abstract explanations of natural things and phenomena characterized the pre-modern sciences worldwide, particularly Chinese elite traditions of natural studies.

Arguably, by 1600, Europe was ahead of Asia in producing clocks, screws, levers, and pulleys that would be applied increasingly to the mechanization of agricultural and industrial production. In the seventeenth and eighteenth centuries, however, Europeans still sought the technological secrets for silk production, textile weaving, porcelain making, and large-scale tea production from the Chinese. Chinese literati in turn, before 1800, borrowed from Europe new algebraic notations (of Hindu-Arabic origins), Tychonic earth-centered cosmology, Euclidean geometry, spherical trigonometry, and arithmetic and trigonometric logarithms.

Allegations that Chinese literati were not curious about European science in the seventeenth and eighteenth centuries are untrue. The Jesuits devised an accommodation approach in China that focused on mathematics and astronomy—an approach that differed from the method they used in Japan, India, Persia, and Southeast Asia, as well as the New World. To gain the trust of the throne and its literati, Matteo Ricci (1552–1610) and his followers prioritized natural studies and mathematical astronomy during the late Ming and early Qing precisely because they recognized that literati and emperors were interested in such fields. They realized that such interest would improve the cultural environment for converting the Chinese to Christianity.

The failure of the Jesuit mission and other Europeans to transmit scientific and mathematical knowledge during and after the Kangxi reign was not due to Chinese disinterest alone, although the Yongzheng emperor did not view them as favorably as did his father. The Chinese absence of knowledge about eighteenth century scientific developments in Europe resulted in part from the break in scientific transmission that the demise of the Jesuits and their schools in Europe during the eighteenth century caused, which deprived Chinese of information about new trends there. The Jesuit demise delayed information from Europe about the role of calculus as the engineer's toolkit, for example, and mechanics as the physicist's building blocks for almost a century.[13]

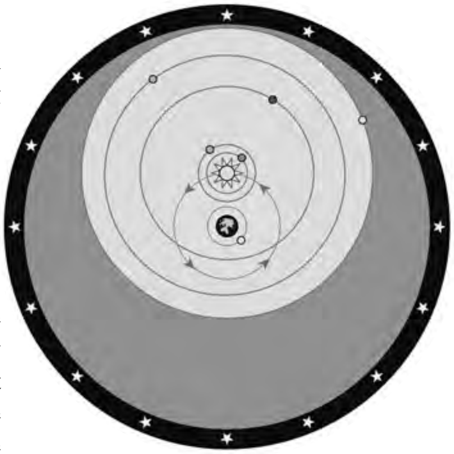

Diagram depicting the basics of the Tychonian geocentric system. Basically, the objects on small, inner orbits (the Moon and the Sun) revolve around the Earth. The objects on large outer orbits (Mercury, Venus, Mars, Jupiter, and Saturn) revolve around the Sun. All are surrounded by a sphere of fixed stars. The system is essentially geocentric, though everything except for the moon revolves around the Sun.
Image source: Wikipedia Commons

The technical competence of the Jesuits in the China mission during the eighteenth century ranged from surveying methods to cannon-making. They also introduced 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. In addition, emperors, their courts, and literati families welcomed Western goods and manufactures, which reverberated in the material culture of Qing novels such as *Dream of the Red Chamber*.

Initially, the Chinese required a higher degree of astronomical expertise than Ricci could provide because Ming needs focused on eclipse prediction based on cyclical time, not the determination of the linear date for Easter. Gregorian reformers in the 1570s had not worried about eclipses. Because their preference was for better cosmology, the Jesuits in China went beyond the geocentric Ptolemaic world after Ricci's death and mastered the new Tychonic geoheliocentric world system. Once this was accomplished, however, the work of Jesuits in the Astro-calendric Bureau became regulatory rather than explorative.

Armed with the intellectual and instrumental tools provided by Brahe and his followers, the Jesuits solved the problems they were hired to undertake. They did not keep up with newer scientific developments in Europe, which more and more were products of northern European Protestants outside the Church. Consequently, the Tychonic system was still used to train astronomers in Qing China during the late nineteenth century. The Manchu emperors reproduced the institutional models for translation that Ming literati such as Xu Guangqi (1562–1633) had created with the help of Matteo Ricci and Li Zhizao (1565–1630).

The breakdown of the Jesuit consensus in the eighteenth century coincided with increasing Chinese self-reliance in mathematical training and acceptance of European learning as rooted in China's ancient classics. Under imperial patronage, literati upgraded mathematical studies from an insignificant skill in 1700 to an important domain of knowledge that complemented classical learning by 1800. One irony of the failure of the French Jesuits to keep up in mathematics and science was that, although French Jesuits had corresponded with Leibniz (1646–1716), the inventor of the notational forms for the calculus that French engineers employed during the eighteenth century, the Jesuits—not the Chinese—failed to see beyond the Figurist mysteries they read into the binary mathematics in the order of the sixty-four hexagrams of the *Change Classic* (*Yijing*), a divination text of imminent transformations that took its final form as one of the Five Classics during the Han dynasty.

The leaders of the 1793 Macartney mission had 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 manufacturing leaders of Europe and as enthusiastic teachers of their new scientific knowledge. Lord Macartney (1737–1806) believed that the gifts he 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 geocentric armillary spheres, mechanical clocks, and telescopes previously introduced by the Jesuits. He also thought that such gifts would convince the Qianlong emperor of Britain's dominance in science and technology.

Neither Macartney nor his ship's mechanic and mathematician James Dinwiddie (1746–1815) thought much about the fact that the British East India Company had purchased the German-made planetarium at an auction and coated it in oriental style for the Chinese market. Only when he visited the lavish Qing imperial gardens filled as he himself noted "with spheres, orreries, clocks, and musical automatons of such exquisite workmanship" did Macartney stop to consider the limits of his gifts. Savants in London had already ridiculed the intended gifts for China as a banal effort to redress Britain's large deficits in the China trade. When someone suggested that the Chinese might be more interested in British machinery, that was set aside out of fear that the clever Chinese would quickly learn how to copy export machinery, as American machinists mischievously had.

Indeed, Macartney never presented the pulleys, air pump, chemical and electrical contrivances, or Watt's steam engine models that he had on board. Nor did the mission present the chronometer Macartney also brought as a possible gift. A new means to determine longitude, the chronometer would have been more efficient than the Jesuit method for surveying used by the Manchus to appraise their domains. Instead, the apparatuses were returned to the British East India Company or given to Dinwiddie, who lectured on them and presented some experiments in

Only when he visited the lavish Qing imperial gardens filled "with spheres, orreries, clocks, and musical automatons of such exquisite workmanship" did Macartney stop to consider the limits of his gifts.

. . . by looking at the long-term development of natural studies in China since 1600, we should acknowledge the qualified success of modern science in China—even though there were many obstacles and setbacks along the way.

Guangzhou to the English Factory, which was attended by Chinese merchants. Macartney remarkably noted: "Had Dinwiddie remained at Canton and continued his courses, I dare say he might have soon realized a very considerable sum of money from his Chinese pupils alone."[14]

The comparisons of early modern Europe and late imperial China presented in this article suggest a number of ways that comparative history can lead us in new directions. First and foremost, historicizing the Western scientific revolution makes it possible to compare the ongoing role played by classical languages (Latin in Europe, ancient Chinese in China) as cultural mediums during the transition from natural philosophy to early modern science. Secondly, differential studies that wield appropriate concepts and categories for comparing precise historical situations are mandatory. In particular, case studies can successfully integrate scientific contents and historical contexts as the key to moving from the local to the global and back again. A global account that is misinformed about local or regional realities will not get it right.

In this essay, I have argued that by looking at the long-term development of natural studies in China since 1600, we should acknowledge the qualified success of modern science in China—even though there were many obstacles and setbacks along the way. Thus, I oppose recent wishy-washy calls for a "no-fault" historiography that absolve earlier Euro-Americans for their longstanding claims of scientific, cultural, and religious superiority. Such "no-fault" views also preempt recent positive narratives about early modern Chinese, Islamic, and Sanskrit exact studies.[15] The rehabilitation of the exact sciences in the premodern non-Western world is a long-term precondition for balancing the historiographical playing field. If China did not "fail" to develop modern science, then we should also acknowledge the modest successes in early modern and modern science there.[16]

To reconsider the standard textbook narrative in which late imperial Chinese elites are usually considered to be anti-science and anti-technology, we should explore Chinese interests in natural studies as they articulated and practiced them, rather than speculate about why they did not accomplish what the Europeans did. Whenever appropriate, we should contextualize Chinese natural studies by comparing the lingering vitality of the pre-modern exact sciences in China with the decisive turn toward Newtonian mechanics and industrial revolution in eighteenth century France and England. We should also reconsider the rapid industrialization of Europe in the nineteenth century in light of the slower but equally extraordinary rise of modern Chinese machine-driven industry after 1860.[17] ■

NOTES

1. Alain Peyrefitte's *The Immobile Empire: The First Great Collision of the East and West*, translated by Jon Rothschild (New York: Albert Knopf, 1992), paints a dark picture of Qing cultural xenophobia and conservatism. For correctives, see Joanna Waley-Cohen, *The Sextants of Beijing: Global Currents in Chinese History* (New York: W. W. Norton & Company, 1999).
2. Michael Adas, *Machines as the Measure of Men: Science, Technology, and Ideologies of Western Dominance* (Ithaca: Cornell University Press, 1989).
3. See Joseph Needham et al., *Science and Civilisation in China* (Cambridge, England: Cambridge University Press, 1954), especially Volume 3, 150–168.
4. See Nathan Sivin, "Why the Scientific Revolution Did Not Take Place in China—or Didn't it?" published in Sivin, *Science in Ancient China* (Aldershot, Hants: Variorum, 1995), Chapter VII, and at: http://ccat.sas.upenn.edu/~nsivin/scirev.html. See also Roger Hart, "Beyond Science and Civilization: A Post-Needham Critique," in *East Asian Science, Technology, and Medicine* 16 (1999), 88–114.
5. Bernard Cohn, *Colonialism and Its Form of Knowledge: The British in India* (Chicago: University of Chicago Press, 1996), 5–56. Compare Deepak Kumar, ed., *Science and Empires: Essays in Indian Context, 1700–1947* (New Delhi: Wiley Eastern, 1991), and Satpal Sangwan, *Science, Technology and Colonisation: An Indian Experience, 1757–1857* (New Delhi: Anamika Prakashan, 1991).
6. Gyan Prakash, *Another Reason: Science and the Imagination of Modern India* (Princeton: Princeton University Press, 1999), 3–14, 17–85.
7. Peter Perdue, *China Marches West: The Qing Conquest of Central Asia* (Cambridge: Harvard University Press, 2005), and Laura Hostetler, *Qing Colonial Enterprise: Ethnography and Cartography in Early Modern China* (Chicago: University of Chicago Press, 2001).
8. Elman, "Naval Warfare and the Refraction of China's Self-Strengthening Reforms into Scientific and Technological Failure," *Modern Asian Studies* 38, 2 (2003): 283–326.
9. Louise Levathes, *When China Ruled the Seas: The Treasure Fleet of the Dragon Throne, 1405–1433* (Oxford University Press, USA; Reprint edition, 1997). Compare Gavin Menzies' well orchestrated science fiction entitled *1421: The Year China Discovered America* (New York: HarperCollins, 2002).
10. Richard von Glahn, *Fountain of Fortune: Money and Monetary Policy in China, 1000–1700* (Berkeley: University of California Press, 1996).
11. Cynthia J. Brokaw, *The Ledgers of Merit and Demerit: Social Change and Moral Order in Late Imperial China* (Princeton, NJ: Princeton University Press, 1991).
12. Nicolas Standaert, S. J., "The Investigation of Things and the Fathoming of Principles (*Gewu qiongli*) in the Seventeenth-Century Contact Between Jesuits and Chinese Scholars," in John W. Witek, S.J., ed., *Ferdinand Verbiest (1622–1688): Jesuit Missionary, Scientist, Engineer and Diplomat* (Nettetal: Steyler Verlag, 1994): 395–420.
13. Elman, *On Their Own Terms: Science in China, 1550-1900* (Cambridge: Harvard University Press, 2005), 160–189.
14. 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 (1981): 503–525. See also George Macartney, *An Embassy to China; being the journal kept by Lord Macartney during his embassy to the Emperor Ch'ien-lung, 1793–1794*, edited, with an introduction and notes by J. L. Cranmer-Byng (London: Longmans, 1962): 266. I have also benefited from Simon Schaffer, "Instruments as Cargo in the China Trade," *History of Science* 44 (2006): 1–30.
15. Bruno Latour's *We Have Never Been Modern*, translated by Catherine Porter (Cambridge: Harvard University Press, 1993), describes the difficulties in pretending that we have left the past behind. Sheldon Pollock's *The Language of the Gods in the World of Men: Sanskrit, Culture, and Power in Premodern India* (Berkeley: University of California Press, 2006) successfully recaptures the traditions of Sanskrit exact learning that generations of British imperialism disavowed.
16. For opposing views, listen to the recent BBC program aired on October 19, 2006, entitled "China and The Needham Question," at http://www.bbc.co.uk/radio4/history/inourtime/inourtime_20061019.shtml, which is part of the BBC's "In Our Time" Radio Series.
17. Elman, *A Cultural History of Modern Science in China,* (Cambridge: Harvard University Press, 2006).

BENJAMIN ELMAN is Professor of East Asian Studies and History at Princeton University where he teaches undergraduate courses on the intellectual, cultural, and social history of China, as well as a sophomore initiative seminar dealing with the reliability of "The Travels of Marco Polo," the Jesuit's contributions to Chinese studies, and the cultural impact of the Sino-Japanese War of 1894-95. Professor Elman recently completed a book project entitled *A Short Cultural History of Modern Science in Late Imperial China* (Harvard, 2006). He is currently engaged in a study of cultural interaction in East Asia during the 18th century. He is also coauthor of a forthcoming world history textbook (the companion volume to *Worlds Together, Worlds Apart* (2002) that when released in fall 2007 will cover prehistoric times up to 1300.