Regimes Of Scientific And Military Knowledge In Mid-Nineteenth Century China: A Revisionist Perspective

Harriet T. Zurndorfer

Abstract

Because so much of China's nineteenth century history is castigated as 'failure', there has not been enough attention paid to the kinds of advancements in science, technology, and modern warfare that China did in fact pursue, especially in the period 1865-95. However, recent revisionist scholarship has demonstrated there is certain evidence of China's achievements in these fields, and in particular, in shipbuilding, in the adaptation of Western weaponry, in the establishment of modern well-equipped arsenals, and in the creation of 'manufacturing' machines. Moreover, the translation of scientific, military, and technological texts from European languages that helped actualize China's 'modernization' along these lines, also set the basis for Japan's own translation of these same kinds of references.

This paper has two goals: to demonstrate in broad brush terms how contemporary globalizing discourses on scientific and military knowledge did in fact penetrate the mind-set of nineteenth century Chinese intellectuals and scholar-officials; and secondly, to indicate how these discourses were obfuscated and expurgated. Ultimately, distortions of China's mid-nineteenth experiences with changing regimes of knowledge helped create the conventional bifurcated assessment of two kinds of learning, 'Western' and 'Chinese' claimed by late Qing dynasty reformers. In this way, the actual transcultural circulation of regimes of knowledge has been obscured, and our understanding of China's first practices with modern science, technology, and weaponry clouded by modern narratives which repeat the reformers' formulae, and which situate the origins of China's modernization only after the downfall of the Qing government in the early twentieth century.

Introduction

A common reaction to any mention of China during the nineteenth century is usually the word 'failure', and typically with an implicit comparison

of Western 'success'. Along with economic downturn (why no capitalism?), and political crisis (why no democracy?), the state of Chinese science, technology, and military knowledge during that epoch has been rebuked (Elman 2004a:55): the consequence of China's reluctance, or inability, to renovate and to transform itself according to global standards of progress and performance. Aside the usual 'laundry list' of Chinese 'faults' including "Confucian disdain for commerce, repression of trade by the bureaucracy, neglect of military technology by a pacifist literati elite, or inadequate specialization in the rural economy" (Islamogu/Perdue:272), conventional analyses of nineteenth century China, predictably, undervalue the significance of the country's establishment of new arsenals, shipyards, technical schools, and translation bureaus during that epoch. Nor do they explore in what ways China's own 'modernization' impacted Meiji Japan's efforts at industrialization and development.

But as recent revisionist scholarship has demonstrated, in the matter of the Chinese economy, it is a mistake to consider the late Qing a simple case of decline and collapse. Important studies by Li Bozhong, Robert Marks, Sucheta Mazumdar, Peter Perdue, Kenneth Pomeranz, and R. Bin Wong have argued persuasively that the imperial state did not uniformly repress commerce; literati elites went into joint ventures with merchants; peasant marketing developed vigorously; agrarian productivity rose in the advanced regions; and technological innovation continued in the agrarian economy through the eighteenth century. The Qing imperium maintained a functioning grain supply level that could maximize food resource accessibility (Will; Will and Wong), and fostered alternative sources of monetary copper to stabilize the bimetallic currency system (Vogel). During the eighteenth century Qing endorsement of overseas trade with European nations and Southeast Asia encouraged the integration of domestic shipping networks which linked northern ports in Shandong, Zhili (including Tianjin) and Manchuria's Fengtian with the southern Chinese provinces (Guangdong,

Fujian), and thus to the foreign trade at Guangzhou (Canton) (Huang Guosheng). Even during the first decade of the next century, China continued to enjoy an imbalance of silver payments in its favour, earned from an extensive international commerce in the sale of its tea, porcelain, silk and cotton textiles, as well specialist goods such as alum (Marks; Souza; Zurndorfer 2005). Madeleine Zelin's study of the nineteenth century economy has shown that Qing government economic policies were 'relatively benign', limiting neither the movement of capital and workers, nor the entrepreneurial energies of merchants and manufacturers. Moreover, as both Pomeranz and Wong have argued, the similarities between Qing China and Europe invite comparison of the two locations well into the nineteenth century.

Other current revisionist scholarship has demonstrated the inadequacies of 'pure' culturalist explanations for China's problems with Britain in the late eighteenth/early nineteenth centuries. Lydia Liu's important book *The Clash of Empires: The Invention of China in Modern World Making* examines contemporary Qing sources pertaining to the Macartney embassy, and reveals the Qing court's awareness of Britain's ambitions. She refers to an edict that the Qianlong Emperor sent to his chief state minister upon hearing about the British intent to send an embassy; in this document, the monarch asserted: "...among the western ocean states, England ranks foremost in strength. It is said that the English have robbed and exploited the merchant ships of the other western ocean states so that the *yi* (barbarian) people along the western ocean are terrified of their brutality" (Liu:58). Similarly, another recent study, authored by Frederic Wakeman, has claimed Qianlong's successor, the Jiaqing Emperor's (r.1796-1820) perception of Britain's imperial intent and of its advanced military technology (Wakeman; cf.Peyrefitte:262-347). Wakeman discusses the matter of this emperor's reaction to Britain's attempt to wrestle Macao from the Portuguese in 1808; the Qing monarch in a demonstration of his will against foreign

encroachment conveyed an army of 80,000 troops to the Guangzhou region to prevent an incursion there.

In this essay, we will attempt to follow a comparable perspective to reconsider mid-Qing China's experience with changing regimes of [useful and reliable] knowledge (hereafter, URK). We argue that it is misleading to situate Chinese attitudes toward knowledge of modern science, technology or warfare as simply a 'reaction' to the Western impact, or merely a fulfilment of mid-century Self-Strengthening programs. Rather, we will show that China did entertain a changing regime of knowledge whose significance in the long run has been obscured by twentieth century narratives that situate the origins of modernization after the Qing government's demise. We begin our discussion with an overview of what circumstances contributed to the Qing empire's declining resources before the mid-nineteenth century.

China on the Eve of the Great Divergence

As a number of modern scholars have confirmed, China was at its zenith during the eighteenth century (Naquin/Rawski; Rawski; Rowe; Spence; Waley-Cohen). Whatever interruptions to commercial expansion or population growth the 1643-60 Ming-Qing dynastic transition had halted were, by then, a 'matter of history': cities thrived, and cultural life flourished. The magnificence of Qing material wealth and artistic achievement, recently exhibited at the British Museum mammoth show, "China, The Three Emperors, 1662-1795," was an important facet of this multicultural and cosmopolitan regime. At the same time, the Manchu rulers continued to conduct major military campaigns to extend the Qing empire as far as possible. The 1759 annexation of Xinjiang (i.e. Turkestan) in Central Asia had increased the territorial bounds of Qing sovereignty by millions of square kilometres, which provided opportunities for settlers anxious to escape pressures born out of the swift doubling of the population since the late

seventeenth century. Although there is some reason to doubt the real effectiveness of the Qianlong Emperor's 'Ten Great Military Campaigns' (1747-92) which made adversary rulers of Nepal, Burma, and Vietnam as well as rebel leaders in Taiwan yield to Qing power, the message of his 'imperial project' endured well after his death in 1799 (Woodside). In any event, these military operations attested the government's highly developed logistical capabilities which featured an efficient bureaucracy able to sustain large numbers of troops in a variety of environments, from deserts to tropical mountain areas.

The eighteenth century also saw the resuscitation of interest in indigenous science and mathematics, a development that was to facilitate the comprehension of differential and integral calculus several decades later (Elman 2005). Interestingly, it was already in the second half of the eighteenth century that Chinese scholars had become extremely sceptical about the European astronomy that the Jesuits had continued to practice under imperial auspices (Zurndorfer 1988). Because the Jesuits had withheld so much information about contemporary mathematical discoveries -- such as probability, analytical geometry, infinitesimal calculus, the rebirth of numbers theory, or the evolution of symbolic algebra, Chinese scholars had problems incorporating what they themselves observed and calculated, with all the inconsistencies and inaccuracies they detected in Jesuit-generated astronomy (Waley-Cohen:108-09). While success at the examination system remained the principal objective of most Qing intellectuals in 1800, the content of these exams forced them to contemplate a wide variety of skills and problems: questions dealing with the statecraft issues of fiscal policy, military organization, and political institutions were included (Elman 2002:361).

Although the circumstances which caused a reversal of Qing China's fortunes at the end of the eighteenth century are complex, one may trace the onset of 'darkening shadows', as prophesied in the *Book of Changes* with the

statement 'when the sun is at its peak, it begins to set', to China's frontiers. It was there that the first of a series of uprisings under the influence of sectarian religion, e.g. the White Lotus cult, occurred. The seven year campaign (1796-1803) to suppress this movement was said to have cost about thirty percent more than the central government's entire annual income (Waley-Cohen:133). In overcrowded regions such like Sichuan, the White Lotus rebels gathered adherents and spread their influence toward the northwest in mountainous border areas from where they raided, recruited, and resisted the Qing forces sent to destroy them. Another major rebel force was the Miao aboriginal people, concentrated in Guizhou province where ethnic friction between Han settlers attended by Chinese merchants and the local inhabitants caused disruption, and eventually, wide-scale revolt (1795-1806). These two rebellions formed part of a series of fifteen major uprisings that occurred between 1795 and 1840, during which time there was also an upsurge of piracy in Asian waters (Waley-Cohen:129).

In his path-breaking new book *China Marches West*, Peter Perdue has linked China's military prowess during the eighteenth century on the frontiers with 'a set of logically independent elements' that advanced the Qing downtrend in the nineteenth century (Perdue:551-63). These include the accidents of timing of geopolitical relations, the misapplication of north western policies to southern environments, local power imbalances in regions of the Qing 'negotiated state', and the impact of commercialization on social solidarity. Perdue observes that the Qing state still holding fresh memories of the mid-century victory against what had been their greatest enemy, the Zunghar Mongols, did not view the British on the south coast a serious threat. Many of the same Qing officials who had supervised the policies that had brought these Mongols down, tried to apply similar tactics to the challenge of the 'sea nomads'. But coastal defence and opium suppression needed a different kind of strategy. Moreover, during the early years of the nineteenth century, in the mountainous terrain of the frontier

regions, the government's 'flexible' policy of 'negotiation' with local power holders began to shift toward decentralization, as those with hereditary authority (*begs, jasaks,* and *lamas*) became increasingly indifferent to Beijing's rulership. Finally, private commercial exploitation of the frontier, while benefiting the merchant class, did not necessarily help the state--over time, a merchant-local official nexus developed which provided local officials with independent sources of revenue and personal wealth from the central bureaucracy, a prelude to the mid-nineteenth century *lijin* tax on commerce directed into provincial coffers (cf. Zurndorfer 2004a).

Qing trade balances were severely affected by 1825 with the success of the British EIC's efforts through a mixture of middlemen (Britons, Indians, Armenians, and Parsees) to sell opium to China systematically, which in the long run deprived its fiscal regime of what had once been a steady income of minimum two to three million taels of silver from legitimate commerce (Marks:178-9). Moreover, because China was so tightly integrated into the global economy by then, it could not avoid the international ramifications of the Napoleonic Wars (1793-1815). These clashes had set off a series of emancipation movements in Latin America, the major source of China's money supply, which in effect reduced the global supply of silver and gold. For China, the consequences were profound. As Waley-Cohen writes (133): "the supply of silver [was] cut just when population growth and commercialization increased demand. It caused a worldwide depression that, among other things, reduced demand and hence prices for Chinese tea." Our synopsis of China's passage from the late eighteenth to the early nineteenth posits that the opium problem accelerated existing 'downhill' trends and thus was not the sole reason for China's economic and political problems at that time. At this point, we should also acknowledge Qing perceptions of these problems and how a number of scholar-officials pursued concrete solutions to redirect China's declining fortunes.

An Alternative Perspective to China's Encounter with 'URK' from Abroad

One of the first attempts by China to adopt foreign technology for military purposes was made by a leading scholar and statesman, Ruan Yuan (1764-1849) who as successive governor of the coastal provinces of Zhejiang and Guangdong, oversaw the adaptation of new weapons and ships of foreign design to fight piracy during the period 1796-1809 (Wei). He introduced a new class of foreign vessels based on Annamese design that was capable of carrying heavy cannons to check raids on maritime shipping. Ruan employed shipwrights from coastal provinces to build new models based on captured pirate vessels while he had gunsmiths take the Annamese copper cannons as prototypes to manufacture. Ruan's interest in foreign technology and science was also manifested in his important compilation, *Chouren zhuan* (Biographies of astronomers and mathematicians; 1799) which summarized the works of 280 mathematicians and astronomers, including thirty-seven Europeans; this collection encouraged Chinese intellectuals to relate what knowledge from India, Persia, and Europe had been transmitted into China.

Ruan Yuan was associated with the revival of a political movement known as *jingshi* (statecraft) in the nineteenth century. In general terms, the goal of 'statecraft' thinkers was to search for wealth and power within a Confucian framework of ethical principles. Another advocate of this statecraft 'school' was Wei Yuan (1794-1856) who also became preoccupied with military solutions to domestic rebellions and piracy. Wei was co-editor of an influential compilation of essays, *Huangchao jingshi weibian* (Collected writings on statecraft of this august dynasty) begun in 1825, a work that included, among other matters, discussion of military affairs, and in particular, inner frontier and coastal defence. Wei's study associated China's external vulnerability with internal weakness that was manifested in fiscal complications. Wei embraced proposals for financial reform, advocating the

expansion and improvement of native silver mines as the best way to reduce China's dependence on foreign currency supplies, and as a counterforce to the drain of Chinese silver in opium commerce (Mann Jones/Kuhn:150).

But it is Wei Yuan's later analysis, *Haiguo tuzhi* (Maps and documents on maritime countries; originally published in 1844, followed by several expanded editions), 'the first modern collection of reference texts on Westerners, their countries, and skills' (Masini:23), that marks a new stage in changing Chinese attitudes toward knowledge about foreign powers. Although this sixty-chapter work surveyed many facets of European (and American) engagement in Asia, Wei's purpose in compiling this semi-encyclopaedia of 'matters Western', including military technology, was clear: to offer a counter to British offence. He advocated that China team up with Britain's enemies in Southeast Asia to exploit the weaknesses of its far-flung empire, and that China adopt Western technology, particularly ships and weaponry to help both the suppression of domestic rebellion and the encroachment of Western powers along the coast (Leonard).

Haiguo tuzhi was the first systematic attempt to diffuse information on the West and its military technology. Its genesis would not have been possible without the series of missionary translations that had previously spurred a number of other Chinese scholar-officials to write about coastal defence. The early Protestant evangelical movement, born out of the 'Great Revival' in Britain and the 'Great Awakening' in America (cf.Thorne), brought missionaries to Singapore, and Guangzhou during the first decades of the nineteenth century, and it was they who initiated projects to present in the Chinese language, Western works on history, geography, natural history, medicine, mechanics, and mathematics. In the hope to attract potential converts, these Protestant activists produced treatises and journalistic portraits of Western political institutions and economic prosperity.

Missionary publications were important to Lin Zexu (1785-1850), the imperial commissioner sent by the Beijing authorities in 1839 to Guangzhou

to curb the opium problem. As Lin became acquainted about the West and its achievements through these translations, he realized that China's knowledge of Europe and America was obsolete. Utilizing the information rendered in Chinese from the monthly periodical *The Chinese Repository* by the American missionary Elijah Bridgman (1801-61), and the *Eastern-Western Monthly Magazine* by the German Karl Gützlaff (1803-51), Lin issued his survey *Sizhou shi* (Gazetteer of the four continents; 1841). This latter work became the basis of Wei Yuan's *Haiguo tuzhi*, as well as another Chinese scholar's study of Western geography, Xu Jiyu's (1795-1873) *Yinghuan zhilüe* (Brief survey of the maritime circuit; 1848) containing forty-four Western style maps (Drake). Both the *Haiguo tuzhi* and the *Yinghuan zhilüe* were enormously popular in Japan where in 1850 the authorities tried to proscribe them.

As is well-known, Lin's efforts to take control at Guangzhou of the opium problem failed, and the British challenged Qing authority over southern China in what is now known as the Opium War (1839-42). This conflict proved a turning point in Chinese military development. As one military historian has written: "...the Chinese war junks, muskets, and military organization, which were not too far from 'state of the art' at the beginning of the Opium War, looked woefully outdated by the end of the conflict" (Elleman:25). At the onset of the conflict the British superintendent Charles Elliot expressed his concern that the vast size of the Chinese fleet might simply overwhelm his own forces. In fact, it was not until the arrival of the British steamship 'Nemesis' in 1841 that the tide of war changed. British sailing ships had failed to penetrate China's coastal defences; it was recorded that a two-hour pounding administered by a seventy-four gun warship had virtually no effect on Guangzhou's massive, fortified walls (Waley-Cohen:145). In the end, China's defeat in this war was due to Britain's superior technological power, a phenomenon that did <u>not</u> go unnoticed by Qing authorities who quickly adopted the enemy's military

hardware. According to Waley-Cohen (145-46), "they copied British double-decked men-of-war, complete with guns, and built armed replicas of the British paddle-wheel steamers that had so effectively operated in Canton's shallow waters; they experimented with a form of the percussion cap; they devised an iron mould for casting ordnance (in place of the old sand mould) that was at least as sophisticated as those found in the West, and they steadily cast ships' guns that exactly resembled British models."

One may surmise that these endeavours by Qing China at information retrieval and military innovation became a classic case of "too little too late." But such a judgment should not deter us from considering the period from the late eighteenth century in another way, i.e. not backwards, "over the historical shoulder of the events of the 1840s and 1850s -- the Opium Wars, and the Taiping Rebellion," but via a forward perspective, i.e. the capability and efficacy of the Qing government to accommodate itself to changing circumstances in the nineteenth century (Mann Jones/Kuhn:160).

This notion of a changing perspective on Qing history also applies to the post-Taiping reforms that have usually been studied not for their potential, but in the light of China's defeat by Japan in the Sino-Japanese War of 1894-95. Admittedly, while the Opium War did not lead to any widespread Chinese interest in URK from the West, a phenomenon probably due in part to the Qing government's preoccupation with domestic insurrection and anarchy in inland frontier regions, the situation after the Taiping Rebellion (1850-64) was remarkably different. Because this massive uprising destroyed the heartland of Qing learning, i.e. Suzhou, Nanjing, Yangzhou, and Hangzhou in Jiangnan where schools, libraries, academies, and printing houses had once flourished, the entire organizational structure of academic scholarship was in need of rehabilitation. Many literati, some of whom had become refugees, were now drawn to Beijing and Shanghai, and other urban enclaves where new intellectual institutions began to develop and influence Chinese learning.

The Bridge between Chinese and Western Regimes of URK, 1860-95

The central institution which dominated all facets of changing scientific, technological, and military regimes of knowledge in China during the second half of the nineteenth century was the Jiangnan Arsenal, established in Shanghai in 1865 by the two well-known political military leaders active in the suppression of the Taipings, Zeng Guofan (1811-72) and Li Hongzhang (1823-1901). According to a recent revisionist study of this institution by Meng Yue, the Arsenal was more than 'the greatest manufacturing center of modern arms in East Asia' (cf. M.Wright:211-12). Meng considers the Arsenal the outcome of social and cultural practices of science and technology that emerged in the post-Taiping aftermath. She argues that the Jiangnan Arsenal was in fact a tripart enterprise in which the manufacture of ships, weapons, and machines, the creation of a new institutional category of engineers (i.e. machine workers), and the translation of scientific and technical texts were fundamental occupations (Meng:29).

While it is beyond the limits of this paper to discuss at length the exact achievements of this Arsenal, many of which have also been examined in the context of what some scholars call the 'Self-Strengthening Movement'(cf.Kennedy), we will mention some highlights. In the eight years between 1868 and 1876, the Arsenal built eleven ships of which ten were fitted for war (Meng:16-17). Thereafter, shipbuilding shifted to other locations, and the Arsenal adapted its machinery to produce guns and small arms for field and naval use, including front-loading, steel bore, wrought-iron-barrelled guns modelled after those from the Armstrong factory in Britain. In the 1890s the Arsenal also manufactured rapid-firing machine guns, including those capable of launching forty-pound and hundred-pound shells. According to Meng Yue (30), by 1892 the Jiangnan Arsenal had thirteen branch factories, including 1,947 workshops with a total of 2,982 workers, and possessed 1,037 sets of machines capable of producing

forty-seven kinds of machines, as well as two major ironworks and steelworks.

One of those other sites where shipbuilding took place, and where training in the Western sciences, engineering, and technology featured was the Fuzhou (Fujian) Naval Yard. This institution relied upon French expertise, and was supervised by the Chinese scholar-official Shen Baozhen (1820-79) (Pong). The Fuzhou undertaking has been compared favourably to Japan's Yokosuka Dockyard, also under the direction of French engineers (Hashimoto). During the thirty-year period 1861-1892, some twenty-four major arsenals were built all over China to meet the Qing government's twin goals of strategic industrialization and modern military production (see map in Elman 2005:389).

To return to the activities of the Jiangnan Arsenal, we also refer to its machine manufacture activities. After the arrival of the first set of machines which had been purchased by Rong Hong (1828-1912), the first Chinese to graduate from an American university, eight foreign technicians and 600 workers from Thomas Hunt and Co. were transferred directly to the Jiangnan Arsenal to help launch the enterprise to manufacture machines for making armament. The Arsenal also launched the careers of a number of China's pioneering 'engineers', self-taught technological masters, such as Xu Shou (1818-84), Hua Hengfang (1830-1902), Xu Jianyin (1845-1901), and the former astronomer Jia Buwei (1840-1903) all of whom were credited by their contemporaries for their textual and mathematical expertise (D.Wright; Meng:27). Several of these individuals were well-acquainted with foreign weaponry and engineering before the Arsenal's founding, e.g. Xu Shou and Hua Hengfang had built the first Chinese steamship in 1863, based on the design published in *Bowu xinbian* (Collection of new scientific knowledge; 1853 by Benjamin Hobson) (Meng:31).

The third major enterprise of the Arsenal, the translation program, involved a number of foreigners, including the British sojourner John Fryer

(1829-1928) who helped introduce the new wave of scientific culture sweeping Britain, Europe, and post-Civil War America. The principal focus of the program was its production of a series of industrial treatises on technology and machinery. Most of these foreigners (including Fryer) were not particularly well-qualified in science (in contrast to their Chinese interlocutors who were 'of exceptional scientific talent'. As David Wright has argued (239): "the extent of the foreigner's role was to interpret a text into colloquial Chinese of sufficient intelligibility for the so-called 'amanuensis' to render it into literary Chinese." The Arsenal's teams of translators compiled glossaries and vocabularies so that terminology could be systematized. They also translated German military handbooks after one Chinese literatus realized the significance of the Franco-Prussian War. From the 1870s, the Arsenal also began to purchase Krupp-made weapons and munitions, and then issue German models of rifles and guns (van de Ven:263).

Translation activities were not a monopoly of the Jiangnan Arsenal. In 1862, an interpreters school, known as the Tongwenguan, was founded in Beijing by two reformist court leaders, Prince Gong (Yixian; 1833-98) and Wenxiang (1818-76); the curriculum of this institution featured not only the study of English, French, Russian and German, but also after 1867, astronomy and mathematics, and after 1879, physics, chemistry, physiology, and international law. Other important institutions which provided a systematic source of information to promote science and industry was the Shanghai Polytechnic Institution and Reading Room which became the venue from where Fryer and Xu Shou began in 1877 to publish monthly in English *The Chinese Scientific and Industrial Magazine: A Monthly Journal of Popular Information Relating to the Sciences, Arts, and Manufactures of the West* (Elman 2005:310). With some 3000 copies per issue distributed in more than twenty-seven trading centres in China and Japan, this periodical became an important vehicle for those intellectuals wanting to know more about the contemporary sciences and technology. In general, by the 1870s,

it would seem that the Christian missionaries (who were not without their critics among more conservative Qing officials) were just as much, or more so, involved in translation work as in pastoral activities. Elman surmises that many of these missionaries had become 'minions' of the Qing dynasty, like their Jesuit predecessors whose scientific work outweighed their proselytizing pursuits (Elman 2005:356-57).

These translation institutions also impacted Japan where from the 1850s the afore-mentioned studies by Wei Yuan, Lin Zexu, and Xu Jiyu became well-known. The missionaries' Chinese translations of works dealing with symbolic algebra, calculus, Newtonian mechanics, and modern astronomy led quickly to Japanese renditions of these studies based on Chinese conceptualization, and so Chinese words for scientific terminology began to replace those once derived from Dutch learning (*Rangaku*), e.g. the Chinese word for chemistry *huaxue* (study of change) supplanted the former Japanese word *semi* (after 'chemie' in Dutch) (Elman 2004b:313). It is also remarkable that many of the Japanese neologisms used in China toward the end of the nineteenth century actually had their origins in the 1860s and 1870s when the Japanese borrowed widely from Chinese terminology.

This 'broadbrush' survey of major institutions that contributed to China's acquisition of contemporary scientific, technical, and military knowledge may also be observed in terms of what intellectual space such matters occupied among the Qing authorities and their Chinese literati supporters. Previous to the nineteenth century, scientific knowledge such as that presented by the Jesuits was known as *Xixue* (Western learning) which was interpreted according to native traditions of scholarship (Zurndorfer 2004b). But in the aftermath of the Taiping Rebellion, the Qing government, now anxious to prepare China against further domestic insurrection and foreign incursion, sanctioned the efforts of those like Xu Shou or the missionary-trained great mathematician Li Shanlan (1810-82) to build conceptual bridges between the more recent scientific and military 'Western

learning' and Chinese science. Their task was in effect to incorporate this Western knowledge into the Chinese idea of *gezhi* (an abbreviation of the expression *gewu zhizhi* which means literally, 'the extension of knowledge by investigation of things').

Both Meng Yue and Benjamin Elman have argued that by the second half of the nineteenth century the original meaning of the term *gezhi*, which had first been utilized by the Neo-Confucian scholar Zhu Xi (1130-1200), was transformed in the broadest possible way to include what we nowadays term the humanities as well as the exact sciences, such as chemistry and physics (Meng:31-2; Elman 2004a:49-53). *Gezhi* 'filled up' a legitimate space once occupied by eighteenth century *kaozheng xue* (evidential research studies) that had focused on philology, mathematics, and astronomy. *Kaozheng xue* was in fact the paradigm in which the first Qing *gezhi* practitioners had been educated, and thus their interest in Western knowledge should be viewed in that context. *Kaozheng* with its 'respect for evidence and attention to detail', its focus on translation and phonology, and not least, with its affinity to moral purpose that contextualized practical applications and skilful techniques to Confucian ethical standards, was embedded into the mid-nineteenth century interacting complex of learning procedures, insights, and concepts (cf.D.Wright:71; Reynolds).

Moreover, because of the importance of *kaozheng* to *gezhi* practitioners, we may dismiss the 'diffusion model of scientific transmission': "diffusion implies that the host culture is a passive receptacle for science rather than an active participant in the process of transmission" (D.Wright:401). As David Wright has convincingly elucidated in his important volume, *Translating Science: The Transmission of Western Chemistry into Late Imperial China, 1840-1900*, which provides the most comprehensive and penetrating study of the achievements of the nineteenth century conveyors of URK, the translators themselves not only were charismatic individuals open to foreign ideas but also cognizant of what constituted

Chinese science and technology. Given the dynamic collaboration of such scientist-engineer-translators, especially Xu Shou, Xu Jianyin, and Hua Hengfang, their involvement in the tranmission process demonstrates the essential continuity between, and not alienation from, the earlier paradigm (ibid.). The relationship between *kaozheng* and *gezhi* may also be ascertained in the 1886 sequel to Ruan Yuan's *Chouren zhuan*, the *Chouren zhuan sanbian* (Part three of 'biographies of astronomers and mathematicians'), compiled by Zhu Kebao (1845-1903) who recorded the lives and scientific work of over 437 men and women (!), Chinese and foreign, who made contributors to science, including 200 Qing figures.

Meng sees the *gezhi* cultural enterprise as a 'hybrid' phenomenon, defying simple bifurcations of 'modern' versus 'pre-modern' science. As she contends (34): "the rhetorical and conceptual *gezhi* framework in which scholar-officials and translators presented technological information...denied an absolute West/China dichotomy and [tried to] reconcile the distinct cultural origins of texts and scientific systems." By example, she refers to the preface written by the translator of David A. Wells' *Principles and Applications of Chemistry* (1871) who recorded that the "the translator's job was not only to find Chinese words for Western meanings, but also to match Western concepts with existing Chinese concepts" (Meng:34). Meng emphasizes that the Chinese translators who were aware of the differences between Western and Chinese knowledge systems, did not attempt to present their info as something 'new'. For instance, she remarks, in the case of chemistry, "a discipline which is said to have been 'unknown' to the Chinese before the 1920s" (as claimed by Reardon-Anderson), the nineteenth century translator used extant Chinese terms for two-thirds of the sixty-four elements, and for the remaining elements invented nomenclature using pre-established ways of creating Chinese characters (Meng:35; see Masini:154-56 for the complete list of elements).

Given the fact that the civil service examination system continued to function until 1905, one may well ask how did the *gezhi* paradigm influence the scholar-elite's commitment to the exam exercise. In answer, one may refer to the number of notable officials such as Feng Guifen (1809-74) who made proposals to alter the content of the examination fields to include mathematics. Feng advocated the civil service exam be divided into two, with one group of questions demonstrating mastery of machines and physics (Elman 2004a:51). By 1887 questions on science and mathematics were set in the examinations (Morgan:66). With the backing of highly-placed Qing officials, John Fryer instituted a prize contest in 1886 which allowed those literati proficient in the civil service exams to write about foreign subjects, including science and technology. In the 1889 essay contest, Li Hongzhang set one of the questions: "*Gezhi* in the [classic] *Great Learning* was followed by more than a few dozen theories. Are they similar to present learning in the West? In the West, *gezhi* learning from the time of Aristotle in ancient Greece to Bacon in England changed tremendously and became more refined after Bacon. Now there are Darwin and Spencer. Can you explain these changes?" (cited by Meng:36n.77). Fryer, Li Hongzhang, and other statecraft scholar-officials were able to use the prestige of the imperial exams to aid efforts to promote URK, and to build connections between science, contemporary European thought, and the Chinese classics (Elman 2003). Thus, it would seem by the 1880s, *gezhi* was no longer considered subordinate to dynastic orthodoxy.

Intellectual Backlash: From 'Hybrid' Science to 'Western' Science

China's defeat in the Sino-Japanese War 1894-95 set in motion a series of intellectual changes that in the long term would muddle the significance of *gezhi* to the transmission of URK during the second half of the

nineteenth century. Both local and foreign observers considered China's performance in this confrontation a sham, and in other words, a manifestation of the country's 'failure' to modernize. But once again, recent revisionist scholarship on the Sino-Japanese war challenges the 'witch-hunt' in search of China's inadequacies, and offers some specific alternatives to account for what happened. In a path-breaking study, Allen Fung finds that the primary explanation for China's losses in the land war of this conflict was due to better military training that the Japanese troops and officers received compared to their Chinese counterparts, and second, the fact that Qing troops were outnumbered by the Japanese at the major battles. Fung views the demise of the Beiyang Fleet, while damaging to Chinese confidence and prestige, not as significant as the success of the Japanese troops in the Pingrang and Yalu campaigns which put Beijing at risk. Thus, China's defeat may have been more due to the effectiveness of Japanese drilling and artillery training than to any general inadequacy of its own forces.

Nevertheless, rather than focus on this kind of military assessment, the general reaction both then, and to a certain extent now (cf.Paine), assigns the Qing government the primary blame for its ineptitude to produce modern military and industrial power. In the aftermath of this war, well-known reformist scholars such as Kang Youwei (1858-1927), Liang Qichao (1873-1929), and Yan Fu (1853-1921) began to gather political support to promote Western-style governmental institutions. To achieve this goal, Liang denigrated *gezhi*, and advanced the category *Xixue* as a means to build a new Western-style political system. According to Meng Yue (41-2), Liang's 1896 bibliography *Xixue shumu biao* (Bibliography of Western learning) exemplifies his endeavour: "while *gezhi* in the arsenal environment had referred to a wide range of scientific and technological knowledge (including social science), in Liang's bibliography, it was utterly separated from [general industrial] learning and reduced to a technical term" (cf.Wang). Of the 355 titles in this bibliography, 165 had first been published in the

Jiangnan Arsenal, but in Liang's classification scheme here, most of these *gezhi* works were now subsumed under the category 'Miscellaneous', as opposed to the two more prestigious sections, 'Western learning' or 'Western politics'. In effect, Liang's classification schema trivialized *gezhi* to be merely the study of physical things. And close examination of another compilation by Liang, *Xizheng congshu* (Collectanea of the Western art of government; 1897) reveals once again how he tried to erase the *gezhi* achievement. Here in this compilation, works dealing with agriculture, manufacturing and commerce, together with history, political systems, education, law, and military sciences (some 101 titles out Liang's total 169), which had all been produced at the Jiangnan Arsenal by *gezhi* advocates, were now categorized *Xixue*. The implication of this re-arrangement was profound: while *gezhi* had once been perceived as 'an independent field of science' open to diversity and hybrid practices, *Xixue* was seen as learning that belonged to the West only.

Liang was not alone in his denigration of the achievements of *gezhi*, The conservative scholar-official Zhang Zhidong (1837-1909), probably best known for coining the cliché *Zhongxue weiti, Xixue wei yong* (Chinese studies as fundamental, Western learning as useful) also obscured the validity of *gezhi*. Unlike the Jiangnan Arsenal translators who tended to break down the boundaries between knowledge 'systems', Zhang perpetrated the distinction between Chinese and Western genealogies of knowledge that had once pervaded late seventeenth discussions of learning, but had been abandoned (Meng:41). Because Zhang's purpose was to renew Qing imperial authority at the centre in order to dominate relations with modern European nations, he would not allow *gezhi* to blur his design for political order; in his view, *gezhi* was nothing more than "a small tool in the specialized tool box of Western learning" (*ibid*).

The 1898 Reform movement dealt yet another blow to the mediating realm of *gezhi*. The 'flood' of popular journals that saturated the thirst for

change during the hundred days before and after the Reform actions transformed the China/West dichotomy into an 'inferior/superior' hierarchy. Meng Yue finds examples of this phenomenon in the popular journal *Gezhi xinbao* (Scientific review) which subscribed to the policy 'West is best'. She cites a series of editorial statements in the 'question and answer' section of the August 16, 1898 issue informing readers: "Westerners liked coffee because it was healthier than Chinese tea; Christianity was better than Buddhism;...that Westerners' dance parties had no flirting and so were ethically superior to Chinese festival gatherings..." (Meng:44).

And so, *Xixue* became even more popular after the failure of the Hundred Days of Reform. From then onward, the *'Zhongxue* versus *Xixue'* binary dominated the dialogue of any discussion of China's political future while *gezhi* was dismissed altogether. It would seem that the *gezhi* discourse, at whatever level, conceptual or institutional, was now relegated useless: "...translated books were dismissed as no longer of use or value; available categories and materials were proclaimed to be outdated; even the manufacture of armaments, which had been launched as a Western-style enterprise, was now thought of in terms of 'Chinese' military factories, which were of course backward...." (Meng:44). Yan Fu, another Reform advocate, in a letter to a newspaper in 1900 asserted the lack of Western knowledge in China, and the shortage of qualified science teachers. In the same document, he made no mention of the relatively extensive system of missionary-sponsored education nor the published mathematics textbooks that had been produced by the Jiangnan Arsenal (Huters:182-83).

By the early twentieth century, *gezhi* with its multiple identities of science and technology and hybrid origins, was effectively wiped out, and 'modernization' began to mean 'Westernization'. Now both Liang Qichao and Zhang Zhidong revised the titles of their publications with the words *xinxue* (new learning) which implied Chinese learning was 'old' learning, and thereby defective. In the second decade of that century, the radical May Fourth

reformers, proclaimed modern science had been virtually nonexistent in China. Following Yan Fu's first-time usage of the word *kexue* (science) [which in fact was a 'loanword' from the Japanese expression *kagaku* (Masini:185)], in his 1900 translation of Adam Smith's *Wealth of Nations* (Yang), intellectuals began to drop the expression *gezhi* altogether. By 1915 one of the founders of the Chinese Communist Party, Chen Duxiu (1879-1942) appealed to readers of the first issue of the journal *Xin qingnian* (New youth) to welcome (the imaginary guest) "Mr. Science". Thus, in the same year when the journal *Kexue* (Science) first appeared, most Chinese scholars and thinkers, and their students, truly believed the West was the universal starting place of all science (Elman 2005:418).

Implications

In his appeal for new ways beyond the centre-periphery concept to read knowledge-relations, the distinguished historian of science, Roy Macleod alerts us to the intellectual fallacy of letting an idea be taken as sufficient explanation of its cause. He also reminds us that the transmission of science is not a one-way affair, and that the pursuit of natural knowledge may be tied to political and economic agendas. In this paper, we have tried to reveal the complexity of legacies, and the combination of motives among those who adapted and practiced URK in China before the twentieth century, and what befell that heritage. We have suggested other ways of locating this encounter beyond the modernization narrative, and that Chinese intellectuals did in fact engage in an imperial project to master and to accommodate URK in their own terms.

In a certain sense our investigation of changing regimes of scientific and military knowledge is integral to a recent, broader historiographical shift in China studies that is re-writing the late nineteenth/early twentieth century juncture (e.g, Duara; Hershatter et.al.; Karl/Zarrow). Those modern scholars

providing an alternative to the 'failure/modernization' narrative have aimed "to probe beneath the rhetoric of the nation-state to understand the multiple social formations, political processes, geographical and regional boundaries, and other complexities that national rhetoric strives to erase" (Mann:3-4). Instead of simple teleologies or binaries, this new work stresses permeability, openness, and a certain kind of cosmopolitanism of this era; it encourages re-evaluation of what once was positioned in the modernization narrative, China's 'failure' to integrate into the currents of global-wide 'progress'. While this new historiography has already manifested itself in the study of gender, class, and race (e.g. Fong/Qian/Zurndorfer; Karl; Crossley, respectively), less attention has been paid to the realm of knowledge relations. Hopefully, this paper here will help stimulate others to consider new ways of viewing URK in China's long history.

Bibliography

[Bibliographical Note: In addition to the references listed here, there are useful essays in two remarkable collections which explore in great detail the lexical and conceptual adaptation of global knowledge into Qing China. See Michael Lackner, Iwo Amelung, and Joachim Kurtz, eds., *New Terms for New Ideas: Western Knowledge and Lexical Change in Late Imperial China* (Leiden: Brill Academic Publishers, 2001) and Micheal Lackner and Natascha Vittinghoff, eds., *Mapping Meanings: The Field of New Learning in Late Qing China* (Leiden: Brill Academic Publishers, 2004)]

Crossley, Pamela. 1999. *A Translucent Mirror: History and Identity in Qing Imperial Ideology* (Berkeley: University of California Press).

Drake, Fred W. 1975. *China Charts the World: Hsu Chi-yü and His Geography of 1848* (Cambridge, MA: East Asian Research Center, Harvard University).

Duara, Prasenjit. 1995. *Rescuing History from the Nation: Questioning Narratives of Modern China* (Chicago: University of Chicago Press).

Elleman, Bruce A. 2001. *Modern Chinese Warfare, 1795-1989* (London: Routledge).

Elman, Benjamin. 2002. "The Social Roles of Literati in Early to Mid-Ch'ing," in Willard Peterson, ed., *The Cambridge History of China, vol.9 part 1: The Ch'ing Empire to 1800* (Cambridge: Cambridge University Press), 360-427.

-----. 2003. "The Chinese Prize Essay Contest and the Late Qing Promotion of Modern Science," Paper presented at the Conference 'Salient Features of East Asian Education' (Taipei, Taiwan; 29-30 December).

-----. 2004a. "From Pre-Modern Chinese Natural Studies to Modern Science," in Michael Lackner and Natascha Vittinghoff, eds., *Mapping Meanings: The Field of New Learning in Late Qing China* (Leiden: Brill Academic Publishers), 25-73.

-----. 2004b. "Naval Warfare and the Refraction of China's Self-Strengthening Reforms into Scientific and Technological Failure, 1865-1895," *Modern Asian Studies* 38.2:327-54.

-----. 2005. *On Their Own Terms: Science in China, 1550-1900* (Cambridge, MA: Harvard University Press).

Fong, Grace, Nanxiu Qian, Harriet Zurndorfer, eds.. 2004. *Beyond Tradition and Modernity: Gender, Genre, and Cosmopolitanism in Late Qing China* (Leiden: Brill Academic Publishers).

Fung, Allen. 1996. "Testing the Self-Strengthening: The Chinese Army in the Sino-Japanese War of 1894-1895," *Modern Asian Studies* 30.4:1007-31.

Hashimoto, Takehito. 1999. "Introducing a French Technological System: The Origin and Early History of the Yokosuka Dockyard," *East Asian Science, Technology, and Medicine* 16:53-72.

Hershatter, Gail, Emily Honig, Jonathan Lipman, and Randall Stross eds.. 1996. *Remapping China: Fissures in Historical Terrain* (Stanford: Stanford University Press).

Huang Guosheng. 2004. "The Chinese Maritime Customs in Transition, 1750-1830," in Wang Gungwu and Ng Chin-keong, eds., *Maritime China in Transition 1750-1850* (Wiesbaden: Harrasowitz), 169-89.

Huters, Theodore. 2005. *Bringing the World Home: Appropriating the West in Late Qing and Early Republican China* (Honolulu: University of Hawai'i Press).

Islamoglu, Huri and Peter C. Perdue. 2001. "Introduction to Special Issue on Qing and Ottoman Empires," *Journal of Early Modern History*, 5.4:271-281.

Karl, Rebecca. 2002. *Staging the World: Chinese Nationalism at the Turn of the Twentieth Century* (Durham, NC: Duke University Press).

Karl, Rebecca and Peter Zarrow. 2002. *Rethinking the 1898 Reform Period: Political and Cultural Change in Late Qing China* (Cambridge, MA: Harvard University Press).

Kennedy, Thomas. 1978. *The Arms of Kiangnan: Modernization in the Chinese Ordnance Industry, 1860-1895* (Boulder, CO: Westview Press).

Leonard, Jane Kate. 1984. *Wei Yuan and China's Rediscovery of the Maritime World* (Cambridge, MA: Council on East Asian Studies).

Li Bozhong. 1998. *Agricultural Development in Jiangnan, 1620-1850* (Basingstoke: Macmillan).

Liu, Lydia. 2004. *The Clash of Empires: The Invention of China in Modern World Making* (Cambridge, MA: Harvard University Press).

Macleod, Roy. 2001. "Introduction," *Nature and Empire: Science and the Colonial Enterprise* [special edition of *Osiris* 15], 1-13.

Mann, Susan. 2004. "Introduction," in Grace S. Fong, Nanxiu Qian, and Harriet Zurndorfer, eds., *Beyond Tradition and Modernity: Gender, Genre, and Cosmopolitanism in Late Qing China* (Leiden: Brill Academic Publishers), 3-11.

Mann Jones, Susan and Philip Kuhn. 1978. "Dynastic Decline and the Roots of Rebellion," in Denis Twitchett and John K.Fairbank, eds., *The Cambridge History of China, vol.10 part 1: Late Ch'ing, 1800-1911* (Cambridge: Cambridge University Press), 107-62.

Marks, Robert. 1998. *Tigers, Rice, Silk, and Silt: Environment and Economy in Late Imperial South China* (Cambridge: Cambridge University Press).

Masini, Frederico. 1993. *The Formation of Modern Chinese Lexicon and Its Evolution Toward a National Language: The Period from 1840 to 1898* (Berkeley: Journal of Chinese Linguistics [Monograph Series, No.6]).

Mazumdar, Sucheta. 1998. *Sugar and Society in China: Technology and the World Market* (Cambridge, MA: Harvard University Asia Center).

Meng Yue. 1999. "Hybrid Science versus Modernity: The Practice of the Jiangnan Arsenal, 1864-1897," *East Asian Science, Technology, and Medicine* 16:13-52.

Morgan, L.G. 1933. *The Teaching of Science to the Chinese* (Hong Kong: Kelly and Walsh).

Naquin, Susan and Evelyn Rawski. 1987. *Chinese Society in the Eighteenth Century* (New Haven: Yale University Press).

Paine, S.C.M. 2003. *The Sino-Japanese War of 1894-1895: Perceptions, Power and Primacy* (Cambridge: Cambridge University Press).

Perdue, Peter C. 1992. "The Qing State and the Gansu Grain Market, 1739-1864," in Thomas Rawski and Lilian Li, eds., *Chinese History in Economic Perspective* (Berkeley: University of California Press), 100-25.

-----. 2005. *China Marches West: The Qing Conquest of Central Asia* (Cambridge, MA: The Belknap Press of Harvard University Press).

Peyrefitte, Alain. 1992. *Un Choc de cultures: la vision des Chinois* (Paris: Fayard).

Pomeranz, Kenneth. 2000. *The Great Divergence: Europe, China, and the Making of the Modern World Economy* (Princeton: Princeton University Press).

Pong, David. 1994. *Shen Pao-chen and China's Modernization in the Nineteenth Century* (Cambridge: Cambridge University Press).

Rawski, Evelyn. 1996. "Presidential Address: Re-envisioning the Qing: The Significance of the Qing Period in Chinese History," *Journal of Asian Studies* 55.4:829-50.

Reardon-Anderson, James. 1991. *The Study of Change: Chemistry in China, 1840-1949* (Cambridge: Cambridge University Press).

Reynolds, David. 1991. "Redrawing China's Intellectual Map: Images of Science in Nineteenth Century China," *Late Imperial China* 12.1:27-61.

Rowe, William. 2002. "Social Stability and Social Change," in Willard Peterson, ed., *The Cambridge History of China, vol.9 part 1: The Ch'ing Dynasty to 1800* (Cambridge: Cambridge University Press), 473-562.

Souza, G.B. 2004. "Country Trade and Chinese Alum: Raw Material Supply in Asia's Textile Production in the Seventeenth and Eighteenth Centuries," *Revista da Cultura* 11:136-53.

Spence, Jonathan. 1990. *The Search for Modern China* (New York: W.W. Norton & Co.).

Thorne, Susan. 1997. '"The Conversion of Englishmen and the Conversion of the World Inseparable': Missionary Imperialism and the Language of Class in Early Industrial Britain," in Frederick Cooper and Ann Laura Stoler, eds., *Tensions of Empire: Colonial Cultures in a Bourgeois World* (Berkeley: University of California Press), 238-62.

Van de Ven, Hans. 1996. "Recent Studies of Modern Chinese History," *Modern Asian Studies* 30.2:225-69.

Vogel, Hans Ulrich. 1987. "Chinese Central Monetary Policy, 1644-1800," *Late Imperial China* 8.2:1-52.

Wakeman, Frederic Jr. 2004. "Drury's Occupation of Macau and China's Response to Early Modern Imperialism," *East Asian History* 28:27-34.

Waley-Cohen, Joanna. 1999. *The Sextants of Beijing: Global Currents in Chinese History* (New York: W.W.Norton & Co.).

Wang Hui. 1996. "The Fate of Mr.Science in China: The Concept of Science and its Application in Modern Chinese Thought," in Tani Barlow, ed., *Formations of Colonial Modernity in East Asia* (Durham, NC: Duke University Press), 21-81.

Wei Peh T'i. 1979. "Internal Security and Coastal Control: Juan Yuan and Pirate Suppression in Chekiang 1799-1806," *Ch'ing-shih wen-t'i*, 5:83-112.

Will, Pierre-Étienne. 1990. *Bureaucracy and Famine in Eighteenth Century China* (Stanford: Stanford University Press).

Will, Pierre-Étienne and R.Bin Wong. et al. 1991. *Nourish the People: The State Civilian Granary System in China, 1650-1850* (Ann Arbor: University of Michigan Press).

Wong, R. Bin. 1997. *China Transformed: Historical Change and the Limits of European Experience* (Ithaca: Cornell University Press).

Woodside, Alexander. 2002. "The Ch'ien-lung Reign," in Willard Peterson, ed., *The Cambridge History of China, vol.9 part 1: The Ch'ing Dynasty to 1800* (Cambridge: Cambridge University Press), 230-309.

Wright, David. 2000. *Translating Science: The Transmission of Western Chemistry into Late Imperial China, 1840-1900* (Leiden: Brill Academic Publishers).

Wright, Mary. 1966. *The Last Stand of Chinese Conservatism: The T'ung-chih Restoration, 1862-1874* (New York: Atheneum [rev.ed.]).

Yang Wenheng. 1981. "Kexue yici de laili" (The origin of the word kexue [science]), *Zhongguo keji shiliao* 3:101-04.

Zelin, Madeleine. 1991. "The Structure of the Chinese Economy during the Qing Period," in Kenneth Liberthal et al., eds., *Perspectives on Modern China: Four Anniversaries* (Armonk, NY: M.E. Sharpe).

Zurndorfer, Harriet T. 1988. "Comment la science et la technologie se vendaient à la Chine au XVIIIe siècle: Essai d'analyse interne," *Études chinoises* 7.2:59-90.

-----. 2004a. "Imperialism, Globalization, and Public Finance: The Case of Late Qing China" (London School of Economics, Department of Economic History, 'Working Papers of the Global Economic History Network', No.6.

-----. 2004b. "Science without Modernization: China's First Encounter with Useful and Reliable Knowledge from Europe," Paper Presented at the Fourth GEHN Conference, Leiden.

-----. 2005. "Cotton Textiles and Ming/Qing China in the Global Economy (1500-1840)." Paper presented at the Eighth GEHN Workshop; Pune, India (18-20 December).