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Naval Warfare and the Refraction of China's Self-Strengthening Reforms into Scientific and Technological Failure, 1865–1895[1]

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In the 1950s and 1960s, Chinese, Western, and Japanese scholarship debated the success or failure of the government schools and regional arsenals established between 1865 and 1895 to reform Qing China (1644–1911). For example, Quan Hansheng contended in 1954 that the Qing failure to industrialize after the Taiping Rebellion (1850–64) was the major reason why China lacked modern weapons during the Sino-Japanese War.[2] This position has been built on in recent reassessments of the 'Foreign Affairs Movement' (*Yangwu yundong*) and Sino-Japanese War of 1894–95 (*Jiawu zhanzheng*) by Chinese scholars. They argue, with some dissent, that the inadequacies of the late Qing Chinese navy and army were due to poor armaments, insufficient training, lack of leadership, vested interests, lack of funding, and low morale. In aggregate, these factors are thought to demonstrate the inadequacies of the 'Self-Strengthening era' and its industrial programs.[3]

[1] An earlier version was presented at the conference 'The Disunity of Chinese Science,' organized by Roger Hart (University of Texas, Austin), sponsored by the History of Science Program at the University of Chicago, May 10–12, 2002. My thanks to an anonymous reader who suggested parts to expand and who also directed me to important recent work on the topic.

[2] Quan Hansheng, 'Jiawu zhanzhen yiqian de Zhongguo gongyehua yundong,' *Lishi yuyan yanjiusuo jikan* 25, 1 (1954): 77–8.

[3] Compare Jian Duo, 'Zhong-Ri jiawu zhanzheng yu yangwu yundong,' in Qi Qizhang, (ed.), *Jiawu zhanzheng jiushi zhounian ji'nian lunwen ji* (Ji'nan: Ji-Lu shushe, 1986), pp. 426–42; Qian Gang, *Haizang: Jiawu zhangzheng 100 nian* (Taibei: Fengyun shidai chuban gongsi, 1994), pp. 2–3; Dai Yi, Yang Dongliang, and Hua Lizhu, *Jiawu zhangzheng yu Dong-Ya zhengzhi* (Beijing: Zhongguo shehui kexue chubanshe, 1994), pp. 32–46; and Shi Quan, *Jiawu zhangzheng qianhou zhi wan-Qing zhengju* (Beijing: Sanlian shudian, 1997), pp. 1–2, 273. A similar catalog of issues is presented in Kwang-Ching Liu and Richard Smith, 'The Military Challenge: The North-West and the Coast,' in John Fairbank and Kwang-Ching Liu, (eds), *The*

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Allen Fung has recently reconsidered this 'shopping-list of problems' in a review article that perceptively explores the 'witch-hunt for the inadequacies of the Chinese army and navy' that ensued after 1895. Fung focuses on the defeat of the Chinese army in the Sino-Japanese War because Japanese land victories gave them a clear path to march on Beijing. This threat to the capital forced the Qing court to seek an immediate settlement of the war. In contrast to accounts in China that still accuse the key Qing minister, Li Hongzhang (1823–1901), of cowardice for his peace at any cost policy, Fung maintains that Chinese armies were well-equipped during the early stage of the war with Japan and that the Chinese field commanders were not incompetent. He refutes earlier claims that China's land defeats in the Sino-Japanese War were due to the failure of the Chinese ordnance industry. Fung concludes that the primary explanations for China's losses in the land war are: (1) the better military training Japanese troops and officers received when compared to their Chinese counterparts; and (2) the fact that Qing troops were outnumbered by the Japanese at the major battles.[4]

Below, I will reassess the naval wars that the Qing dynasty lost in the late nineteenth century. Along with the Sino-Japanese War, the Sino-French naval battles of 1884–85 have also been used as a litmus test for measuring the failure of the Self-Strengthening reforms initiated after the Taiping Rebellion. The rise of the new arsenals, shipyards, technical schools, and translation bureaus, which are usually undervalued in such 'failure narratives,' will also be reconsidered in light of the increased training in military technology and education in Western science available to Chinese after 1865. Longstanding claims made by contemporaries of the Sino-Japanese War that China's defeat demonstrated the failure of the Foreign Affairs Movement to introduce Western science and technology successfully will be scrutinized.[5]

Cambridge History of China, Volume 11, *Late Qing, 1800–1911*, Part 2 (Cambridge: Cambridge University Press, 1980), pp. 202–73.

[4] Allen Fung, 'Testing the Self-Strengthening: The Chinese Army in the Sino-Japanese War of 1894–95, *Modern Asian Studies* 30, 4 (1996): 1007–31, which appears in a special issue on 'War in Modern China.' Compare Dai Yi, Yang Dongliang, and Hua Lizhu, *Jiawu zhanzheng yu Dong-Ya zhengzhi*, pp. 104–5; Richard Smith, 'Foreign Training and China's Self-Strengthening: The Case of Feng-huang-shan,' *Modern Asian Studies* 10, 2 (1976): 195–223, also stressed the late Qing failure to train a modern officer corps.

[5] On the inadequacy of China's army and navy, see Ralph Powell, *The Rise of Chinese Military Power* (Princeton: Princeton University Press, 1955), pp. 36–50. Compare Richard Smith, 'Reflections on the Comparative Study of Modernization

In addition, my account will address how Chinese naval defeats contributed to the transformation of official, elite, and popular perceptions of the Self-Strengthening era. New public opinions appeared in the Chinese and missionary press that shaped the emerging national identity and sense of crisis among Han Chinese who increasingly opposed the Manchu regime in power. Disappointment with the military losses convinced many Chinese that the Foreign Affairs Movement had failed and that more radical political, educational, and cultural changes were required to follow Japan's lead in modernizing and coping with foreign imperialism. The earlier adaptation of new technological and scientific learning before 1895 was quickly forgotten and repressed. Euro-American missionaries and experts who had aided in the Qing dynasty's scientific translation projects, which were used as textbooks in the arsenals and technical schools, now also thought that the Chinese nation, language, and culture were doomed.[6]

In military terms, the Chinese losses at sea in 1894–95 meant that the Qing development of an ocean-going navy that might have rivaled the Chinese blue water fleets of the early Ming dynasty (1368–1644), when the navy sailed into the Indian Ocean, and the early Qing, when the navy stormed the Pescadores and Taiwan, was derailed in favor of a land-based army built around well-trained infantry forces. One of the ironies accompanying the revival of the Chinese navy after 1865 was that since the Southern Song dynasty (1127–1280) China had at times supported a substantial navy, which the Mongols had expanded to invade Japan and to attack Sumatra. Subsequently, the early Ming navy had carried out enormous excursions into Southeast Asia and the Indian Ocean, which ended when the navy was scrapped in the 1460s to prepare for possible land wars against the Oirat Mongols. The Ming coastal navy then tried unsuccessfully to defend the South China coast from Japanese pirates in the sixteenth century.[7]

in China and Japan: Military Aspects,' *Journal of the Hong Kong Branch of the Royal Asiatic Society* 16 (1976): 11–23.

[6] See Hans J. van de Ven, 'War in the Making of Modern China,' *Modern Asian Studies* 30, 4 (1996): 737–56, which draws on Peter Paret's discussion of the 'new military history,' in Paret's *Understanding War* (Princeton: Princeton University Press, 1992), especially pp. 209–26. Compare Li Kan, 'Jiawu chongji zai sixiang wenxue lingyu yinqi de bianhua,' in Qi Qizhang (ed.), *Jiawu zhanzheng jiushi zhounian ji'nian lunwen ji*, pp. 368–84.

[7] Lo, Jung-pang. 'The Decline of the Early Ming Navy.' *Oriens Extremus* 5, 2 (1958): 147–68. On the army, compare Stephan MacKinnon, *Power and Politics in*

Chinese naval power revived when Ming loyalists under the command of Zheng Chenggong (Koxinga, 1624–62) and his father resisted the Manchus in major naval and land battles along the Fujian coast in the 1640s and 1650s. Zheng's land and sea forces took heavy losses, however, when they moved up the Yangzi River to Nanjing in 1659, and he was forced to retreat to Xiamen (Amoy), where he repulsed Qing forces in 1660. Zheng's naval forces then challenged the Dutch garrison in northern Taiwan at Castle Zeelandia in April 1661 with a force of 600 ships and 25 thousand sailors. The Dutch garrison capitulated after a bitter nine-month siege. Zheng subsequently and unsuccessfully demanded via a Dominican missionary that the Spanish in Manila recognize his suzerainty.[8]

For its part, the Qing government in 1662 ordered coastal inhabitants from Shandong in the north to Guangdong in the south to move inland to cut Zheng's supply lines and to negate the value of the coast as a battleground. In addition, the Manchus developed a naval fleet to defend the coastline. When Shi Lang (1621–96), one of the Southern Ming's most capable admirals, joined the Manchus in 1646 because of a dispute with Zheng, he took command of Qing naval forces in the 1650s and in 1660s along the Fujian coast. In July 1683, Shi Lang commanded the Qing Fleet of 300 warships and 20 thousand sailors, which first subdued the Pescadores. Taiwan fell to the Qing navy in October, and for the first time the island became part of the 'Chinese' empire.[9]

The Qing navy no longer remained on a war footing after Taiwan was annexed, and the Manchu emperors became increasingly preoccupied with the land-based expansion of the Russians from Siberia into the Manchu homelands and the renewed dangers posed by the Zunghars in Central Asia. In addition, the Qing sought expansion of its empire in Tibet and Turkestan. By the end of the eighteenth century, the Qing had doubled its size. When the Opium War broke out in 1839, therefore, the Qing fleet was again mainly a coastal

Late Imperial China (Berkeley: University of California Press, 1980), pp. 90–136, and Edward McCord, *The Power of the Gun: The Emergence of Modern Chinese Warlordism* (Berkeley: University of California Press, 1980), pp. 17–45.

[8] Christine Vertente *et al., The Authentic Story of Taiwan: An Illustrated History, based on Ancient Maps, Manuscripts, and Prints* (Knokke, Belgium and Taibei: Mappamundi Publishers and SMC Publishing Inc., 1991), pp. 96–110. See also Arthur Hummel (ed.), *Eminent Chinese of the Ch'ing Period* [hereafter, *ECCP*] (Washington, D.C.: U.S. Government Printing Office, 1943), pp. 108–9.

[9] Verente *et al., The Authentic Story of Taiwan*, pp. 127–30, and *ECCP*, p. 653.

navy used principally for defense against outside pirates and local marauders[10]

In many ways, the revival of the Qing navy after the Opium wars might have been heralded as a return to the brighter days of the imperial navy during the fifteenth and seventeenth centuries. Instead, however, after the Sino-Japanese War the late Qing navy was ridiculed at a time when anti-Manchu patriots appealed to the Ming fleets as a sign of China's past greatness. Moreover, the alleged superiority of Japan in modern science and technology was generally accepted after 1895 because of the success of its navy.

The Scope and Scale of the Foreign Affairs Movement

In the late 1950s American scholars such as Mary Wright contended that the imperial system and its classical ideology, which she labeled Confucian, were incompatible. The Taiwan scholar Wang Ermin subsequently challenged Wright's claim that classical learning and modernization were incompatible when he traced the beginnings of China's military industrial complex to the Self-Strengthening era. More recently Francis Moulder has maintained that China's failure to modernize should be understood in light of China's higher level of incorporation into the world economy than Japan, which enabled the more deleterious impact of imperialism in China. All three views have been presented in the aftermath of the crucial Japanese victory in 1895, particularly at sea, which decisively refracted Chinese and Western perceptions of the Self-Strengthening era period after 1865. Renewed attention to the 'decisiveness of battle' to evaluate such broad conclusions is required before we can reach a new consensus that corrects the misrepresentations that became dominant after the 1895 'witch-hunt'.[11]

[10] Peter Perdue, 'Boundaries, Maps, and Movement: Chinese, Russian, and Mongolian Empires in Early Modern Central Eurasia,' *The International History Review* 20, 2 (June 1998): 263–86.

[11] Mary Wright, *The Last Stand of Chinese Conservatism: The T'ung-chih Restoration, 1862–1874* (Stanford, Stanford University Press), 1957); Wang Ermin, 'Rujia chuantong yu jindai Zhong-Xi sichao zhi huitong,' *Xinya xueshu jikan* 2 (1979): 163–78. See also Wang Ermin, *Qingji bing gongye de xingqi* (Taibei: Institute of Modern History. Academia Sinica, 1972). Compare Francis Moulder, *Japan, China, and the Modern World Economy: Toward a Reinterpretation of East Asian Development, ca. 1600 to ca. 1918* (Cambridge: Harvard University Press, 1977). Stephen Thomas has argued that the adverse affects of imperialism were not felt in China until the 1890s, after the war. See Thomas, *Foreign Intervention and China's Industrial Development, 1870–*

In his influential study of modern Chinese naval development, for example, John Rawlinson contended that traditional institutions based on classical ideology gave the Tongzhi Restoration (1862–74) and the Foreign Affairs Movement its essential character and limited its achievements. The Qing failure to develop a national navy yielded a number of competing regional squadrons primarily because of weak imperial institutions and strong regional loyalties. Others such as Thomas Kennedy have assessed both the external and internal forces that influenced the efficacy of the Foreign Affairs Movement and its programs.

According to Kennedy, China's modern ordnance industry was an institutional innovation that ushered in new era of mass production. Moreover, the Qing state managed the arsenals as bureaus within the traditional government, which lead to corruption and inefficiency. Poor imperial leadership and lack of coordination among provincial officials limited the success of the modernization programs. Financial troubles at the arsenals and generally poor Euro-American technicians resulted from China's semi-colonial status at the time. In this view, military firepower at sea and on land was not the key to the outcome of the Sino-Japanese War.[12]

David Pong has contended that the Beijing court failed to create a unified imperial navy because of its inability to change the system of public financing and because of insufficient funds. On the other hand, Albert Feuerwerker has noted that the Qing government compensated somewhat for the depressed rural economy after the Taipings by instituting two new taxes to finance the arsenals and shipyards successfully: 1) customs duties on foreign trade; and 2) the *lijin* (likin) tax on inter-provincial domestic trade. Feuerwerker has added that the Qing government could not tap into local economic resources or manage economic life and that the fundamental problem of revenues for reform revealed more internal weakness than outside imperialism. Pong's study uses the Foochow Navy Yard as an example of both the successes and failures of the Foreign Affairs Movement. He has stressed the

1911 (Boulder: Westview Press, 1984), and van de Ven, 'War in the Making of Modern China,' pp. 739–42.

[12] See John Rawlinson, *China's Struggle for Naval Development, 1839–1895* (Cambridge: Harvard University Press, 1967), pp. 198–204. Compare Thomas Kennedy, *The Arms of Kiangnan: Modernization in the Chinese Ordnance Industry, 1860–1895* (Boulder: Westview press, 1978), pp. 146, 150–60.

potential for change in this era and has avoided characterizing Self-Strengthening as a failure.[13]

Japanese scholars of late Qing reform such as Hatano Yoshihiro have singled out the Qing bureaucratic system as the principal factor that preserved the old order in China, not economic backwardness, imperialism, or the inherited ideology and culture. According to this point of view, the Qing bureaucracy and its financial system rewarded imperial officials inordinately while the land market and economic corruption encouraged the status quo. Neither the Qing peasantry nor merchants were protected from official abuses and commercial exploitation.

According to Hatano, Qing officials and literati never fully understood the external crises they faced because they were schooled in the traditional civil examination system and thus were ignorant of the outside world. To make his point, Hatano cites the Jiangnan Arsenal and Fuzhou Navy Yard. Because each was under the control of regional governors or governor-generals they were inefficient, wasteful, and lacked centralized coordination. Non-military enterprises such as the China Merchants' Steam Navigation Company, the Kaiping Coal Mine, and the Imperial Telegraph Administration were all defense oriented, but unlike the arsenals they were organized on a profit-making basis and competed successfully against foreign companies.[14]

Similarly, Itō Shūichi has contended that science and technology in late Qing China required an end to the official orthodoxy and civil

[13] David Pong, 'Keeping the Foochow Navy Yard Afloat: Government Finance and China's Early Modern Defense Industry, 1866–75,' *Modern Asian Studies* 21, 1 (February 1987): 121–52, and Albert Feuerwerker, 'Economic Trends in the Late Ch'ing Empire. 1870–1911,' in John Fairbank and Kwang-Ching Liu (eds), *The Cambridge History of China*, vol. 11, pt 2, pp. 59–68. See also David Pong, *Shen Pao-chen and China's Modernization in the Nineteenth Century* (Cambridge: Cambridge University Press, 1994), pp. 11–20. Kwang-Ching Liu, 'Nineteenth-Century China,' in Ping-ti Ho and Tang Tsou (eds), *China in Crisis* (2 vols, Chicago: University of Chicago Press, 1968), vol. 1, pp. 93–178, had earlier described the *Yangwu yundong* as an early stage of China's institutional reform and not a failure.

[14] Hatano Yoshihiro, 'Chūgoku kindaishi ni kansuru mitsu no mondai—Chūgoku no kindaika wa naze okureta ka,' *Nagoya daigaku bungakubu kenkyū ronshū* 7 (1958): 29–61. See also Hatano, *Chūgoku kindai kōgyō shi no kenkyū* (Kyoto, 1960). Compare Ellsworth Carlson, *The Kaiping Mines, 1877–1912* (Cambridge: Harvard East Asian Monographs, 1971), and Hatano Yoshihiro, 'The Response of the Chinese Bureaucracy to Modern Machinery,' *Acta Asiatica* 12 (1968): 13–28. Compare K. H. Kim, *Japanese Perspectives on China's Early Modernization: A Bibliographical Survey* (Ann Arbor: University of Michigan, Centre for Chinese studies, 1974).

examination reform before they could be advanced. In Itō's view, although they served as a catalyst of the modern intellectual revolution in China, the publication of translated Western scientific works and technical books and the creation of new technical schools after 1865 contributed to the spread of Western social and political ideas among Chinese intellectuals, but the translations per se produced no scientists or engineers.[15].

To challenge negative views of the imperial Chinese state in Japanese scholarship, the eminent sinologist Miyazaki Ichisada, had written an essay to gainsay claims that the Qing bureaucracy control had ruined most of China's early industrial enterprises. According to Miyazaki, Li Hongzhang's desire to check foreign domination of shipping in China had motivated him to sponsor the China Merchants' Steam Navigation Company in 1872. As an 'officially supervised and merchant operated' (*guandu shangban*) enterprise, the China Merchants' Company actually was a government venture, according to Miyazaki. Supported by a total of 2.15 million taels (3 million silver dollars) in long-term, interest-free government loans, the company was the largest shipping firm in China by 1876. Miyazaki ironically has noted that the company declined only after 1909 when it was privatized under the industrialist Sheng Xuanhuai's (1849–1916) personal control.[16]

In his study of the Foreign Affairs Movement, Onogawa Hidemi has described it as part of a wider late Qing reform movement. The first phase focused on technical innovation, while the second phase shifted to institutional innovation after the 1894–95 Sino-Japanese War. In Onogawa's view, the key figures of the first phase of technical and industrial reforms during the 1870s and 80s, such as Xue Fucheng (1838–94), Ma Jianzhong (1844–1900), Guo Songtao (1818–91), and Zeng Jize (1823–90), who served as administrative experts and advisors to many of the chief ministers of the late Qing, advanced mercantilist proposals for developing mining, railroads,

[15] Itō Shūichi, 'Kindai Chūgoku ni okeru kagaku gijutsu no chii—sono shisōshi teki kōsatsu,' *Tōyō gakujitsu kenkyū* 5, 5–6 (1967): 65–77.

[16] Miyazaki Ichisada, 'Shōshō kyoku no ryakushi—Chūgoku no dokusenteki kisen kaisha,' *Tōyōshi kenkyū* 11, 2 (March 1951): 153–59. On this issue, compare Chi-kong Lai, 'Li Hung-chang and Modern Enterprise: The China Merchants' Company, 1872–1885,' in Samuel Chu and Kwang-Ching Liu (eds), *Li Hung-chang and China's Early Modernization* (Armonk, N.Y.: M. E. Sharpe, Inc., 1994), pp. 216–47, and Wellington Chan, 'Government, Merchants, and Industry to 1911,' in John Fairbank and Kwang-Ching Liu (eds), *Cambridge History of China,* vol. 11, pt 2, pp. 422–9.

and foreign trade to create the material wealth needed for military Self-Strengthening.

In late nineteenth century, however, Wang Tao (1828–97) proposed extensive reforms in the civil examination, military, and educational system. Others such as Ho Qi and Hu Liyuan were critical of Li Hongzhang in the mid-1880s because of his focus on the navy rather than basic reforms in internal administration, which they regarded as more pressing. Champions of 'Self-Strengthening' eventually promoted a doctrine of reform. Onogawa's stress on the shift from science and technology to the institutional changes needed in China in the 1880s suggests that the technical achievements before 1895 were recognized but deemed insufficient not in terms of a failure in science and technology but in light of institutional systems that needed reform. Similarly, Yu Mingxia has in a recent PRC account concluded that the Self-Strengthening reforms were in some ways successful despite China's naval defeats.[17]

The Role of Regional Arsenals in the Self-Strengthening Movement

In the summer of 1865, Li Hongzhang as Jiangsu governor and Ding Richang (1823–82) as the Shanghai customs intendent rented a machine shop in the Hongkew section of Shanghai from Thomas Hunt and Company, an American firm in the Shanghai Foreign Settlement that was the largest foreign machine shop in China. Li also approved the purchase of the machine shop and the shipyard of Hunt and Company for use by the Suzhou 'Foreign Arms Office' (*Yangbaoju*). Additional machinery was imported, and subsequently the Jiangnan Machine Manufacturing General Bureau (*Jiangnan jiqi zhizao zongju*), usually called the Jiangnan Arsenal, was established to administer the industrial works and educational offices.

Initially, the Jiangnan Arsenal used 250 thousand taels (348 thousand silver dollars) for production facilities, drawn mainly from maritime customs funds collected at Shanghai. Ding Richang was appointed director in 1865, and Ying Baoshi (b. 1821) was appointed 1866–68. The Arsenal was moved just outside the Chinese city of

[17] Onogawa Hidemi, *Shimmatsu seiji shisō kenkyū* (Tokyo: Misuzu shobō, 1969), pp. 8–85. Compare Yu Mingxia, 'Jiawu zhanzheng shibai xuangao yangwu yundong "chedi pochan" shuo bianxi,' in Qi Qizhang, (ed.), *Jiawu zhanzheng jiushi zhounian ji'nian lunwen ji*, pp. 443–59.

Shanghai in the summer of 1867. According to Mary Wright, by 1870 the Arsenal had become the greatest manufacturing center of modern arms in East Asia and 'one of the great arsenals of the world.'[18]

In her revisionist account of the Jiangnan Arsenal, Meng Yue has described how for Zeng Guofan (1811–72), Li Hongzhang, and their advisors the manufacture of machines represented the fundamental building block for industry. In their view the three basic ingredients for constructing new industry were: 1) manufacturing machines; 2) creating a new institutional category of engineers, lit., 'machine workers'); and third, the translation of scientific and technical texts. Via armaments manufacture, the Qing state would break the Euro-American monopoly of warships and cannons and master contemporary useful knowledge.[19]

Technical work at the arsenal was left in the hands of foreigners such as the American T. F. Falls, Hunt's chief engineer, who was the superintendent. Eight of Hunt's machinists were retained, and six hundred workers from Hunt and Company were transferred directly to the Jiangnan Arsenal. Many others were later added. They produced serviceable muskets and small howitzers after initial failures in rifle production. By mid-1867 the arsenal was producing fifteen muskets and a hundred twelve-pound shrapnel daily. Twelve-pound howitzers were produced at the rate of eighteen per month and used as munitions in the Nian Rebellion of the 1860s. By 1871 the arsenal produced Remington breech-loading rifles. At the end of 1873, 4,200 were produced, but they were more costly and proved inferior to imported Remingtons. In 1874–75, Li Hongzhang advised establishing a branch to produce powder and cartridges instead.[20]

[18] *Jiangnan zhizaoju ji*, compiled by Wei Xiangong (1904. Reprint, Taibei: Wenhai chubanshe). See also Quan Hansheng, 'Qingji de Jiangnan zhizaoju,' *Bulletin of the Institute of History and Philology, Academia Sinica* 23 (1951): 145–59, and Wright, *The Last Stand of Chinese Conservatism*, pp. 211–12.

[19] See the excellent account in Meng Yue, 'Hybrid Science *versus* Modernity: The Practice of the Jiangnan Arsenal,' *East Asian Science, Technology, and Medicine* 16 (1999): 13–52.

[20] Thomas Kennedy, 'The Establishment and Develoment of the Kiangnan Arsenal, 1860–95' (Columbia University Ph.D. dissertation in History, 1968), chapter 2, and *ECCP*, pp. 721–2. See also Knight Biggerstaff, *The Earliest Modern Government Schools in China* (Ithaca: Cornell University Press, 1961), pp. 165–6, and Ting-yee Kuo and Kwang-Ching Liu, 'Self-Strengthening: the pursuit of Western technology,' in Denis Twitchett and John Fairbank, (eds), *Cambridge History of China*, Volume 10, *Late Ch'ing, 1800–1911*, Part 1 (Cambridge: Cambridge University Press, 1978), pp. 519–21.

Technical Learning in the Jiangnan Arsenal

Before the English missionary John Fryer (1839–1928) joined it, the translation project for the Jiangnan Arsenal was very modest. The Chinese and their collaborators planned to produce an encyclopedia of knowledge and information that would resemble the *Encyclopedia Britannica*, but this goal was quickly deemed too elementary and perhaps too traditional, i.e., a mimicking of Ming-Qing encyclopedia (*leishu*) traditions. Instead, the Translation Bureau began producing a series of industrial treatises focusing on technology and machinery, rather than mathematics and the natural sciences, after hiring a core group of Chinese and Western translators.[21]

From 1863, when the Imperial Court approved the creation of the Shanghai School of Foreign Languages (*Tongwen'guan*, lit., 'School of translated learning'), the latter had remained an independent school of translation. In 1869, however, the Shanghai Tongwen'guan was moved into the Jiangnan Arsenal and renamed the 'School for the Diffusion of Languages' (*Guang fangyan guan*). Its new buildings were paid for by the Shanghai Maritime Customs. Fryer's work now turned to translating Western books on manufacturing as Chinese textbooks for the new school, which would include the fields of engineering, navigation, military technology, and naval affairs.[22]

Classical learning was continued in the Jiangnan Arsenal after the Shanghai school moved into the Arsenal. It remained separate from the Translation Department in the hope that its graduates would go on to pass the more prestigious civil examinations. Hence, the school attracted the sons of Shanghai merchants and Christian converts in a more foreign environment. Arsenal students were also drilled in the 8-legged essay at the same time that mathematics was given high priority. For the latter, the 'Ten

[21] Fryer, 'An Account of the Department for the Translation of Foreign Books at the Kiangnan Arsenal, Shanghai,' *North-China Herald*, January 29, 1880, pp. 78–9. Adrian Bennett, *John Fryer: The Introduction of Western Science and Technology into Nineteenth-Century China* (Cambridge: Harvard University Research Center, 1967), pp. 34–5, notes that after 1880, Fryer placed a greater concentration on natural sciences than technology.

[22] Meng Yu, 'Hybrid Science *versus* Modernity,' pp. 32–3. See also Biggerstaff, *The Earliest Modern Government Schools*, pp. 166–7, 173, and Bennett, *John Fryer*, pp. 18–25. Curiously, the *Guang fangyan guan* staff avoided using the texts that Fryer and the Translation Bureau produced. See Fryer, 'An Account of the Department for the Translation of Foreign Books at the Kiangnan Arsenal, Shanghai,' p. 81.

Mathematical Classics,' several of which had been reconstituted by Qing scholars in the eighteenth century, were used to teach traditional Chinese mathematics.[23]

Students studied Western algebra, geometry, trigonometry, astronomy, and mechanics in the lower division curriculum. They were also trained in international law, geography, and mechanical drawing. The upper-division curriculum for students emphasized seven fields: 1) mineralogy and metallurgy; 2) metal casting and forging; 3) wood and iron manufacturing; 4) machinery design and operation; 5) navigation; 6) naval and land warfare; and 7) foreign languages, customs, institutions. It took three years to complete the two divisions. Outstanding graduates, it was hoped, would then take special provincial examinations in Beijing.[24]

At its highest stage of development, the Jiangnan Arsenal contained four institutions: 1) a translation department; 2) a school for training translators and linguists; 3) a school for training skilled workmen; and 4) the machine shop. Meng Yue notes that the Jiangnan Arsenal had thirteen branch factories. By 1892, it occupied 73 acres of land, with 1,974 workshops and a total of 2,982 workers. The Arsenal possessed 1,037 sets of machines and produced forty-seven kinds of machinery under the watch of foreign technicians who supervised production.[25]

Shipbuilding in the Jiangnan Arsenal

From 1868 to 1876, according to Meng Yue, shipbuilding in the Jiangnan Arsenal was highly productive, when eleven ships were built in eight years. Ten were warships. Five of these had wooden hulls; the other five were provided with iron hulls. All parts of each ship, including the engine, were built at the arsenal. The arsenal also experimented with different designs, from single to double-screw, wooden and iron hulls, and simple warships to turreted vessels. When compared to the warships made in the Yokosuka Dockyard in Japan in the 1870s, the level of shipbuilding

[23] Jean-Claude Martzloff, *A History of Chinese Mathematics*, translated by Stephen Wilson (New York; Springer-Verlag, 1997), pp. 225–32.

[24] Biggerstaff, *The Earliest Modern Government Schools*, pp. 166–71.

[25] *Jiangnan zhizaoju ji*, pp. 151–68. See Meng Yue, 'Hybrid Science *versus* Modernity,' pp. 29–30, and Bennett, *John Fryer*, p. 18. See also Biggerstaff, *The Earliest Modern Government Schools*, p. 172.

technology at the Jiangnan Arsenal was actually higher than in the leading Japanese dockyard.[26]

Meng Yue notes that the Yokosuka Dockyard did not produce its largest wooden warships until 1887–88. Two were armed with twelve guns and boasted 1,622 horsepower. Neither was the match for the largest warship built at the Jiangnan Arsenal in 1872, which had 1,800 horsepower and was armed with twenty-six guns. Five iron-hulled warships were produced at the Jiangnan Arsenal before 1875, while the first iron Japanese gunboats were not completed until after 1887. In terms of armaments, those manufactured at the Jiangnan Arsenal were by and large superior to Japan's.[27]

Overall, however, the Chinese fleet of iron and wooden ships quickly fell behind the new ironclad ships of Europe. Moreover, the compound engine in Europe, which China did not begin to build until 1877 because of the lack of funds, superseded the outmoded single or double screw engines in Chinese vessels. Hence, China's ships were still behind Europe's in the 1870s. Moreover, because Chinese shipyards could not produce enough ships, more warships were built in Europe for the Chinese navy. Although foreign technicians were again employed for building large modern warships, Chinese ships were still outmoded by the 1890s because Chinese training could not keep pace with Western technological progress. Japanese officers and sailors, in contrast, were better trained to manage their ships and guns by 1894.[28]

Shipbuilding in the Jiangnan Arsenal dramatically slowed after 1876. In 1885, when the Arsenal completed its first steel gunboat, it ceased to be a military shipyard. The technological switch towards

[26] Meng Yue, 'Hybrid Science *versus* Modernity,' pp. 16–17. Hans van de Ven notes that most scholars are 'in agreement that China's navy was superior to the Japanese,' although the final verdict remains open. See his 'War in the Making of Modern China,' p. 740. Others would argue that such claims are valid only if one uses aggregate measures such as tonnage and weight of shell. The Japanese navy by 1894 was newer, faster, and equipped, as we will see below, with faster firing guns.

[27] *Jiangnan zhizaoju ji*, pp. 319–28, and Meng Yue, pp. 16–24, especially Tables 1 and 2. The latter summarizes Hansgeorg Jentschura, Dieter Jung, and Peter Michel, *Warships of the Imperial Japanese Navy: 1869–1945*, translated from the German by Antony Preston and J. D. Brown (Annapolis, MD: United States Naval Institute 1977), p. 115. Compare Takehiko Hashimoto, 'Introducing a French Technological System: The Origin and Early History of the Yokosuka Dockyard,' *East Asian Science, Technology, and Medicine* 16 (1999): 53–65.

[28] Meng Yue, p. 17. See also Pong, *Shen Pao-Chen and China's Modernization in the Nineteenth Century,* p. 224, and Biggerstaff, *The Earliest Modern Government Schools in China*, pp. 246–7.

steel and armored warships in Europe highlighted the difficulty of transporting iron and coal from inland provinces to make steel in coastal China.[29] At the same time imported steel remained prohibitively expensive to make the ships domestically. Nevertheless, shipbuilding technology in Jiangnan and the Fuzhou Navy Yard probably remained slightly better than in Japanese arsenals until 1889, when French engineers came to Japan and designed new steel and iron warships for the Yokosuka Dockyard. Its first modern warship had more horsepower and a higher top speed than the same type of warship built by the Jiangnan Arsenal.[30]

Once shipbuilding was no longer its major task, the Jiangnan Arsenal adapted its machinery to produce the most advanced foreign guns and small arms for military use. As of 1874, the arsenal had produced a total of 110 cannons and a variety of guns modeled after products from the Armstrong factory in Britain. Three types of large 120 mm, 175 mm, and 200 mm caliber muzzle-loading guns made by the Arsenal were deployed at the Wusong fort guarding the mouth of the Yangzi River. In the late 1880s, the Arsenal produced large breech-loading guns that initially used black and then later brown gunpowder. By 1885, Li Hongzhang favored the German arms industry over the British, and the scale of Krupp arms sales to China increased.

Before the Sino-Japanese War, the Jiangnan Arsenal was producing large breech-loading Armstrong guns whose range went from 7,000 to 11,000 yards. They were capable of firing projectiles from 80 to 800 lbs. The Arsenal also became known after 1890 for its success in producing rapid-firing machine guns, which were important in enhancing sea power and coastal defense forts. By 1892 the Jiangnan Arsenal had manufactured ten 40-pound rapid-firing guns. Two years later, the arsenal was making rapid-firing machine guns capable of launching 40-pound and 100-pound shells. Because annual production in the Arsenal was insufficient to supply the Chinese army, the Qing military still had to purchase such arms from abroad. According to Meng Yue, Japan by comparison did not begin its ambitious artillery program until 1905, during the Russo-Japanese War.[31]

[29] Kenneth Pomeranz, *The Great Divergence: Europe, China, and the Making of the Modern World Economy* (Princeton: Princeton University Press, 2001), notes that China's fossil fuels were relatively inaccessible when compared to Europe's.

[30] Meng Yue, pp. 17–19.

[31] Meng Yue, pp. 21–3. See also *Jiangnan zhizaoju ji*, pp. 374–88, 442, and David Wright, 'Careers in Western Science in Nineteenth-Century China: Xu Shou and Xu Jianyin,' *Journal of the Royal Asiatic Society*, third series, 5 (1995): 80.

The Fuzhou Navy Yard

Besides the Jiangnan Arsenal in Shanghai, the second major industrial site for shipbuilding and training in the Western sciences and technology was the Fuzhou Naval Yard. When Zuo Zongtang (1812–85) submitted his 1866 memorial to establish a navy yard at Fuzhou the expectation was that after five years the need for foreign experts would be eliminated. The estimated start-up costs of 300 thousand taels (417 thousand silver dollars) and the 600 thousand taels (834 thousand silver dollars) for annual operations were to come from maritime customs duties and the inter-provincial trade taxes (*lijin*) collected in Fujian, Zhejiang, and Guangdong provinces. In return, those provinces would receive naval protection from the 'Southern Fleet' based at Fuzhou.

From the start, Zuo and his successor Shen Baozhen (1820–79) relied on French expertise in contrast to the British influence at the Jiangnan Arsenal. Once the navy yard was established, however, only 400 thousand taels (556 thousand silver dollars) were raised from the Fujian maritime customs, with another 50 thousand (69.5 thousand silver dollars) per month for operations, leaving the venture in a perpetual financial bind. At its peak the shipyard employed 3,000 workers in the navy yard. When later construction was completed the force was dropped to 1,900, with 600 in the dockyard, 800 in workshops, and 500 coolies. Some 500 soldiers guarded the premises. The navy yard had more than 45 buildings on 118 acres set aside for administrative, educational, and production purposes. By comparison, the Jiangnan Arsenal as largest ordnance enterprise in 1875 had 32 such buildings on 73 acres.[32]

In terms of scale, the Fuzhou Navy Yard was probably the leading industrial venture in late Qing China. Designed as a Westernized enterprise based on machinery and efficiency, the whole plant was served by a tramway with turntables at important workshops and intersections. The Navy Yard's goal was to build a modern Chinese flotilla between 1868 and 1875. Nineteen ships were planned with 80 to 250 horsepower engines. Of these, thirteen would be transport ships with 150 horsepower engines. Sixteen ships were finished during this time. Ten transports with 100 horsepower engines, and one corvette as a showpiece, with a 250 horsepower engine, were realized in 1869–75 while Shen Baozhen was in charge. Nine of the

[32] Biggerstaff, *The Earliest Modern Government Schools*, pp. 200–8, and Pong, *Shen Pao-chen*, pp. 208–9.

150 horsepower transports cost over 161 thousand taels (224 thousand silver dollars) each; five of the 80 horsepower ships cost over 106 thousand taels (147 thousand silver dollars), with the corvette alone requiring 254 thousand taels (353 thousand silver dollars).[33]

Like the Jiangnan Arsenal, the Fuzhou Ship Yard also compared favorably with the Yokosuka Naval Yard. The latter began in 1865 with a budget of 1.3 million taels (1.8 million silver dollars) for a four-year period, compared to four million taels (5.6 million silver dollars) alloted to Fuzhou over five years. Real expenditures at Yokosuka actually doubled the budget, while the Fuzhou Ship Yard expended 5.4 million taels (7.5 million silver dollars) from 1866 to 1874. By 1868, Yokosuka had completed eight ships with eleven more on the way. In comparison, Fuzhou was also at the forefront of naval and technological development. With two major industrial sites in the Yangzi delta and in Fujian province, the Qing was in aggregate ahead of Japanese modernization efforts in the 1860s and 70s, but such aggregate advantages did not translate into organizational superiority or better training when the Fuzhou naval fleet faced the French flotilla alone, unprepared, and unaided in 1884.[34]

The industrial results in Fuzhou were at first gratifying for the Qing dynasty and praised in the December 10, 1875, *North-China Daily News*. Like the ships build at the Jiangnan Arsenal, however, the Chinese Southern Fleet in Fuzhou harbor were mainly wooden ships and thus vulnerable to European ironclads. Nor were they equipped with the latest compound engines. When faced with war with France in the 1880s and Japan in the 1890s, some Qing officials blamed the French for purposely dumping obsolete equipment and designs on the Chinese navy.[35]

Zuo Zongtang had also suggested opening a school for technical training, which when established was called the School for Navy Adminstration. Foreigners taught English, French, mathematics, and

[33] Zhang Yufa, 'Fuzhou chuanchang zhi kaichuang ji qi chuqi fazhan,' *Jindaishi yanjiusuo jikan* (Taiwan) 2 (June 1971): 177–225.

[34] Pong, *Shen Pao-chen*, pp. 241–3, 261.

[35] Prosper Giquel (1835–86), a French naval officer, who had joined the Chinese Imperial Maritime Customs as a commissioner of customs at Ningbo in 1861 and later in Hankou until 1866, was the foreign director of the Fuzhou Naval Yard based on the contract he signed in 1866. See Steven Leibo, *Transferring Technology to China: Prosper Giquel and the Self-Strengtherning Movement* (Berkeley: University of California Press, 1985), Pong, *Shen Pao-chen*, pp. 214–25, and Biggerstaff, *The Earliest Modern Government Schools*, pp. 203–10.

drafting. At the same time, students were expected to master the *Classic of Filial Piety* and the 'Sacred Edict' and 'Amplified Instructions' of the Kangxi (r. 1662–1722) and Yongzheng (r. 1723–35) emperors, just like candidates for the local civil examinations. The Qing dynasty's long-term goal for the training provided by the French engineers and skilled workmen brought to Fuzhou was to create Chinese naval architects and engineers and to generate modern workmen: carpenters, ironworkers, brass workers, ship construction workers, etc.

Two divisions of French and English schools were set up. The French division included departments of naval construction, design, and apprentices. In the English division there was a naval academy with departments of theoretical navigation, practical navigation, and engine room training. The naval construction department opened first in February 1867 based on a curriculum of French, arithmetic, algebra, descriptive and analytic geometry, trigonometry, calculus, physics and mechanics. The five-year program suffered a high rate of attrition, however. In the first group of 105 beginning students, only thirty-nine remained at the end of 1873.[36]

To train Chinese officers to operate warships, the English division, headed by John Carroll from England, created a department of theoretical navigation with a curriculum as follows:

Arithmetic: for knowledge of fractions, proportions, interest, etc.
Algebra: for quadratic equations of second degree, ratios, proportions, progressions, etc.
Geography: used Anderson's *General Features of the Globe.*
Trigonometry: plane and spherical; for solutions of triangles in navigation and nautical astronomy.
Geometry: used Todhunter's Euclid (three books and part of 6th).
Navigation: used Raper's Correction of Compasses, the Sailings, as usually taught, and the Day's Work.
Nautical Astronomy: finding latitude and longitude methods and errors of the compass.

Besides building the naval yard and training personnel, Shen Baozhen saw to it that fifteen ships were launched between June 1869 and February 1874. However, only nineteen were completed between 1874 and 1897 when problems in the lower caliber of administration were exacerbated after Prosper Giquel's departure.

[36] Biggerstaff, *The Earliest Modern Government Schools*, pp. 203–11. See also B. A. Elman, *A Cultural History of Civil Examinations in Late Imperial China* (Berkeley: University of California Press, 2000), pp. 135, 221–2.

The yard also faced a curtailment of operating funds due to the decline of interest by Beijing and provincial officials.[37]

A period of Qing self-management from 1874 commenced when operations in the Ship Yard carried on without foreign technicians until 1897, when five new French technicians arrived. Nevertheless, the schools were able to attract native students, mainly from the south, until the late 1880s. After 1874, graduates were sent to Europe, especially England and France, for advanced training to keep up with new technological developments. In 1877 Giquel led a party of twenty-six students. Twelve students from the English division went to England with five at the Royal Naval College at Greenwich. Nine of the fourteen students from the French division studied hull construction and engine principles in France; the other five studied mining and metallurgy.

A second group of eight graduates were sent out in late 1882 for three years of advanced training. Five studied fortifications, defenses, and gunpowder explosives in France; two studied navigation and naval command in England; and one went to Germany for training in naval mines and torpedoes. A third group of thirty-three graduates were sent in 1886, with ten from the English division, fourteen from French division, and nine from the Tianjin yard. Thirty completed their training; eighteen studied hydrography, ironclad warship navigation, naval artillery and small arms in England; twelve studied hulls and engines, mathematics and ship construction, river control, bridge and railway construction, and international law in France. A fourth group was scheduled to go to Europe in 1894, but the war with Japan interrupted that.

In 1874, as twenty-one year-old graduate, Yan Fu (1853–1921), for instance, was acting captain of a small steamer owned by the Fujian-Zhejiang administration but not built by the Fuzhou Navy Yard. As a graduate of the Fuzhou naval division, however, Yan was eligible to receive advanced training in Europe. On his return to China he became a dean and professor of navigation and mathematics for many years at the Fuzhou Navy Yard. In the early 1880s he became professor of navigation and mathematics in Tianjin Naval Academy where he was a teacher and administrator for nearly 20 years. After the bitter defeat to Japan in the Sino-Japanese War, an 1896 recommendation that foreign teachers should be hired in China rather than sending students to Europe was considered, but

[37] Biggerstaff, *The Earliest Modern Government Schools*, pp. 214–19.

the Zongli yamen still wished to send the best naval students to Europe for advanced studies. Ten were sent in 1897 for six years of training, but only six went to France. They were recalled in 1900 after 3 years due to insufficient funds.[38]

Both David Pong and Knight Biggerstaff have described how industrial decline at the Fuzhou Navy Yard due to financial troubles had set in by 1876–77. Expenditures totalled 5.35 million taels (7.4 million silver dollars) for the 6.5 years to July 1874. This amount significantly exceeded original estimates, partly due to high costs for foreign wages, which used up 12 thousand taels (16.7 thousand silver dollars) out of the monthly operation cost of between 50 thousand (69.5 thousand silver dollars) and 80 thousand (111.2 thousand silver dollars) taels. By contrast, the total wages of two thousand Chinese workmen amounted to only ten thousand taels (13.9 thousand silver dollars) per month. Corruption and nepotism ate away at rest.

The Chinese staff under Shen Baozhen had to work together with Giquel and his Europeans for construction to remain on schedule. Because the shipyard was financed as a traditional enterprise with numerous sources of income, traditional Qing budgetary practices did not take into account inflation, growth, or retooling. Long-term planning became impossible. After 1880, the Fujian Maritime Customs failed to turn over regularly the full annual allocation of 600 thousand taels (834 thousand silver dollars). By the 1890s, the allocation fell to between 200 thousand (278 thousand silver dollars) and 300 thousand (417 thousand silver dollars) and under 200 thousand taels by 1895. As a result, the schools and naval yard were less active in the critical years of the 1890s.[39]

Western Science in Translation

An 1861 proposal by reformist court leaders in Beijing, principally Prince Gong (Yixin, 1833–98) and Wenxiang (1818–76), called for establishing the General Affairs Office (*Zongli yamen*) to deal with

[38] See Wang Xinzhong, 'Fuzhou chuanchang zhi yange,' *Qinghua xuebao* 8 (December 1932): 27–30, and Biggerstaff, *The Earliest Modern Government Schools*, pp. 223–41. See also Ting-yee Kuo and Kwang-Ching Liu, 'Self-Strengthening: the pursuit of Western technology,' pp. 524–5.

[39] Biggerstaff, *The Earliest Modern Government Schools in China*, pp. 53, 220, 239, 271, and Pong, *Shen Pao-chen*, pp. 266–70. See also Ting-yee Kuo and Kwang-Ching Liu, 'Self-Strengthening: the pursuit of Western technology,' p. 534.

the unprecedented nature of the Western threat the dynasty faced. The proposal also included a plan for a School of Foreign Languages (*Tongwen'guan*) in Beijing. Li Hongzhang advocated similar schools in Guangzhou and Shanghai in 1863. His proposal was based on Feng Guifeng's 1861 recommendation for establishing an arsenal and shipyard in each Chinese port for better arms and ships in defense. Feng had also stressed establishing schools in Guangzhou and Shanghai for instruction in Western languages and science.[40]

Subsequently in 1866–67, a proposal that a Department of Mathematics and Astronomy should be added to the School of Foreign Languages in Beijing was approved. Under this traditional focus, which echoed the Jesuit position in the Ming-Qing Astronomy Bureau and the French Jesuit role in the Academy of Mathematics, the goal of teaching students about modern science was realized through instruction in chemistry, physics, and mechanics. When William Martin (1827–1916) returned to Beijing in 1869 to teach physics, after more advanced study in the United States, he assumed the presidency of the School of Foreign Languages.

Science at the Beijing School of Foreign Languages

Li Shanlan (1810–82) left Shanghai and the Jiangnan Arsenal when he was appointed professor of mathematics at the Beijing School of Foreign Languages after it was upgraded to a college and a department of mathematics and astronomy was added in 1869. Li taught mathematics at the School for thirteen years. A special civil examination in mathematics, however, was opposed in the 1870s, although Li's mathematics examinations at the School of Foreign languages were influential among civil service candidates.[41]

As the capital, Beijing remained a central venue for missionaries such as William Martin who were linked to the School of Foreign Languages and the foreign scholars and Chinese students there. The

[40] Su Jing, *Qingji Tongwen'guan ji qi shisheng* (Taibei: Shanghai yinshuachang, 1985), *passim*. See also Nancy Evans, 'The Canton T'ung-wen Kuan: A Study of the Role of Bannermen in One Area of Self-Strengthening,' *Papers on China* (Harvard), 22A (1969): 89–103.

[41] Hong Wansheng, 'Tongwen'guan suanxue jiaoxi Li Shanlan,' in Yang Cuihua and Huang Yinong (eds), *Jindai Zhongguo keji shi lunji* (Taibei: Academia Sinica, Taiwan, Institute of Modern History, and National Qinghua University, Institute of History, 1991), pp. 215–59. See also Biggerstaff, *The Earliest Modern Governement Schools*, pp. 19–34, and *ECCP*, p. 480.

missionary Society for Diffusion of Useful Knowledge (*Guangxue hui*) in Beijing, for example, also produced an illustrated monthly magazine known as *The Peking Magazine* (*Zhongxi wenjian lu*). The *Magazine* was edited by Martin, among others, and printed from 1872 as a monthly for thirty-six issues before closing in August 1875. Distributed by the Society, the magazine was devoted to Western and international news, but it also included articles on astronomy, geography, and science (*gewu*). William Martin had worked on the journal while heading and teaching at the Beijing School of Foreign Languages. Later, he compiled a selection of articles that were published separately as *Selections from The Peking Magazine* (*Zhongxi wenjian lu xuanbian*) in four volumes in 1877.[42]

Hence, *The Peking Magazine* was a voice for the School of Foreign Languages to promote science and missionary concerns. They supported Li Hongzhang and the Self-Strengtheners in their efforts to reform the Qing regime. Altogether 199 articles (55.1%) in the *Magazine* were produced by the School's teachers or students. Moreover, the journal's role in promoting science and technology as a free monthly facilitated its content to be reprinted in the popular *Review of the Times (Wan'guo gongbao)*, which had originally been called the *Chinese Missionary News* (*Jiaohui xinbao*).

With Young J. Allen (1836–1907) as editor, the *Review of the Times* was published weekly in Beijing from 1874 and monthly after 1889. Both the *Magazine* and the *Review* addressed issues that concerned those employed in the emerging arsenals and shipyards. Of the 361 essays by the fifty-four foreign missionaries, traders, and diplomats, 166 (46%) dealt with the sciences and technology. The topics included the technical fields of astronomy, geography, physics, chemistry, medicine, as well as promoting railroads, mining, and the telegraph. Biographies of Western scientists were also added.

William Martin's efforts to use *The Peking Magazine* to promote science in Beijing was complemented by the numerous contributions of Li Shanlan and his mathematics students in the School of Foreign languages to the journal. Often the examination papers in the sciences and the mathematics homework of Li's students were included in the *Magazine*, thus confirming that it was the School's journal. The

[42] Tian Tao, 'Zhongxi wenjian lu, Gezhi huibian yingyinben xu' (Preface to the reproduction of the *Peking Magazine* and *The Chinese Scientific Magazine*), in *Zhongxi wenjian lu* (Reprint in 4 vols, Nanjing: Guji shudian, 1992), Vol. 1, pp. 2–3. Compare San-pao Li, 'Letters to the Editor in John Fryer's *Chinese Scientific Magazine*, 1876–1892: An Analysis,' *Zhongyang yanjiuyuan Jindaishi yanjiusuo jikan* 4 (1974): 737–8.

March and June 1875 issues, for instance, carried articles dealing with Martin's reaction to examination papers debating whether the earth or sun was at the center of the world.[43]

Students often replied to the section on 'Difficult Questions' and established the precedent for 'Answers to readers' queries,' which also became a regular feature in later science journals in Shanghai. The Beijing *Magazine* was an important model for *The Chinese Scientific and Industrial Magazine* (*Gezhi huibian*), which became the scholarly voice simultaneously of the Shanghai Polytechnic and the Jiangnan Arsenal.[44]

Translations at the Jiangnan Arsenal

We have seen above that in 1867 a Translation Department was initiated at the Jiangnan Arsenal. The initiative was led by Xu Shou (1818–82), Hua Hengfang (1833–1902), and Xu Jianyin (1845–1902), classical scholars with scientific interests. In addition to emphasizing foreign manufacture, Zeng and Li Hongzhang regarded translation as the foundation for learning the techniques of modern manufacture and the mathematics on which they were based. Their precedent was the late Ming and early Qing translation projects that had enabled the imperial calendar to be successfully reformed based on new techniques and models introduced by the Jesuits and used in the Astronomy Bureau.

John Fryer wrote in 1880, for instance, that the Jiangnan Arsenal had published translations of Western works since 1871. By June 30, 1879, some ninety-eight works were published in 235 volumes (*juan*). Of these, twenty-two dealt with mathematics, fifteen were on naval and military science, thirteen covered the arts and manufactures. Fryer reported that another forty-five works in 142 volumes were translated but not yet published, and thirteen other works were in process with thirty-four volumes already completed.

[43] See the mathematics questions and science essays in *Zhongxi wenjian lu*, Vol. 1, pp. 403–4 (1872.2: 10a–b), 411–18 (1872.2: 14a–17b), 481–7 (1873.3: 16a–19b). On the earth versus the sun, see Vol. 4, pp. 189–93 (1875.3: 6a–8a), 351–4 (1875.6: 7a–8b).

[44] See Zhang Jian, 'Zhongxi wenjian lu shulue' (Summary of *The Peking Magazine*), *Fudan xuebao (shehui kexue ban)* 4 (1995): 57–62. Zhang disputes claims that *The Peking Magazine* was mainly concerned with current news and events and literature, although Zhang acknowledges that unlike its Beijing predecessor *The Chinese Scientific and Industrial Magazine* in Shanghai was a more specialized journal focusing on science.

Altogether, the Translation Office had sold 31,111 copies representing 83,454 volumes, and this had been accomplished without advertisements or postal arrangements. A work on the German Krupp guns translated in 1872 sold 904 copies in eight years. Another work on coastal defense published in 1871 sold 1,114 copies in nine years. *A Treatise on Practical Geometry* (1871) sold 1,000 copies in eight years; and *A Treatise on Algebra* (1873) sold 781 copies in seven years. Fryer's work on coal mining published in 1871 sold 840 copies in nine years. Publicizing these works beyond Shanghai, Beijing, and the treaty ports was difficult, and even for the latter venues such numbers were disappointing but not insignificant.[45]

For example, the controversial reformer and classicist Kang Youwei (1858–1927) purchased all the Arsenal works when he was in Shanghai in 1882. Between 1890 and 1892, his disciple Liang Qichao (1873–1929) also purchased many of the Arsenal's translations as well as Fryer's science journal entitled *The Chinese Scientific and Industrial Magazine*. Liang developed an influential reading list based on these materials known as the 'Bibliography of Western Learning' (*Xixue shumu biao*), which was revised and published in 1896. Of these 329 published works, 119 (36%) were translated by Fryer. Tan Sitong (1865–98) began writing on scientific topics in the 1890s and mentioned *The Chinese Scientific and Industrial Magazine* as one of his sources of scientific learning. Tan had visited Fryer in Shanghai in 1893 and bought many of the Arsenal's works.[46]

The second half of the nineteenth century was the 'seeding time' for the modernization of China. During the period from 1850 to 1870, many works on astronomy, mathematics, medicine and related fields of botany, geography, geology, mechanics, and navigation were translated by a core group of Protestant missionaries and Chinese co-workers in Guangzhou, Beijing and Shanghai. Parallel to the arsenals and official schools, private initiatives were also needed to popularize 'modern science' (*gezhixue*) in the treaty ports and among Qing officials and literati.[47]

[45] John Fryer, 'An Account of the Department for the Translation of Foreign Books at the Kiangnan Arsenal, Shanghai,' *North-China Herald*, January 29, 1880, pp. 77–81. See also Bennett, *John Fryer*, p. 42.

[46] Bennett, *John Fryer*, pp. 42–4.

[47] See Knight Biggerstaff, 'Shanghai Polytechnic Institution and Reading Room: An Attempt to Introduce Western Science and Technology to the Chinese,' *Pacific Historical Review* 25 (May 1956): 127–34.

Shanghai Polytechnic and 'The Chinese Scientific and Industrial Magazine'

The Shanghai Polytechnic Institution and Reading Room, where *The Chinese Scientific and Industrial Magazine* was published, had been founded in 1874–75. Its programs promoted the sciences, arts, and manufactures of the West through exhibitions, lectures and classes, and a Chinese Library and Reading Room. Because the Polytechnic did not draw the expected interest hoped for, Fryer and Xu Shou also created the scientific journal in China to reach out to the Chinese in the treaty ports. In 1885, a project for classes and public lectures was finally implemented, and the scientific essay contest was initiated and became popular. Instructional plans included an appointment for a foreign professorship of science, which did not materialize.

Fryer's idea for the new journal immediately drew support from the Society for Diffusion of Useful Knowledge in Beijing, which was closing down in 1875 and ending its illustrated monthly known as *The Peking Magazine* discussed above. The Society's members in Beijing transferred their subscriptions to the Polytechnic. Although the Shanghai journal was published and sold through the Polytechnic, it was a separate enterprise that Fryer and his Chinese assistant took responsibility for. Because Fryer's written classical Chinese was not good enough to produce the journal by himself, he employed Luan Xueqian as his private secretary to help translate the unattributed Chinese articles in the journal. In the past it was assumed these unauthored pieces were all composed by Fryer. Luan was trained at Calvin Mateer's (1836–1908) Hall of the Culture Society (Wenhui guan) school in Shandong, where science and advanced mathematics courses were taught in Chinese.[48]

Fryer had worked with Luan since at least 1877 when *The Chinese Scientific and Industrial Magazine* commenced. Luan Xueqian, for example, prepared an account of a chemistry class at Shanghai Polytechnic before he collaborated with Fryer. Moreover, Luan was probably also involved in the *Science Outline Series* (*Gezhi xuzhi*) and *Science Handbook Series* (*Gezhi tushuo*) that were published from 1882 to 1898. In addition, Luan managed the Chinese Scientific Book Depot (*Gezhi shushi*) for Fryer from 1885, which Fryer eventually turned over to Luan in 1911.[49]

[48] See Biggerstaff, 'Shanghai Polytechnic Institution and Reading Room,' p. 144.

[49] Wang Yangzong, 'Gezhi huibian zhi Zhongguo bianjizhe kao' (Inquiry into a Chinese editor of the Scientific Journal), *Wenxian* 63 (January 1995): 237–43. See

Copies of the Polytechnic journal were available at first at twenty-four and then twenty-seven of the most important trading centers in China and Japan: Beijing, Yantai, Wurong, Shanghai, Hangzhou, Shantou (Swatow), Kobe, Tianjin, Dengzhou, Jiuzhang, Suzhou, Fuzhou, Hong Kong, Yokohama, Niuzhuang, Hankou, Nanjing, Xiamen (Amoy), Guangzhou, Ji'nan, Wuchang, Zhenjiang, Ningbo, Danshui (Taiwan), and Singapore. There were thirty agents in early 1880, which increased to seventy by the end of the year. Although *The Chinese Scientific and Industrial Magazine* continued from *The Peking Magazine*, it went beyond the latter by focusing on the natural sciences and technology in Europe and the United States. With more Chinese participants in the production process, the translations in the Shanghai journal were much better.

The journal initially printed 3,000 copies and usually sold out in several months. Nine months later, the first nine issues were reprinted in a second edition to meet the demand. With 4,000 copies printed per issue at its peak in the 1880s and 1890s, it reached some 2,000 readers in the treaty ports. Fryer hoped that in this way, popular oriented presentations of mathematics and the industrial sciences would become more acceptable among literati and merchants. He expected that *The Chinese Scientific and Industrial Magazine* would also compensate for the limited scope of the Jiangnan Arsenal's translations, which were usually printed in runs of only a few hundred or more copies. Later in 1891, reprints of previous issues were sold.[50]

Altogether, sixty issues were published intermittently over seven years. After 1880, the magazine shifted its emphasis from introductory essays on science to accounts of the basic fields of science. Moreover, Fryer increasingly paid attention to mathematics as the foundation of scientific knowledge. The Polytechnic's teaching program was most effective after 1885 when it pioneered the teaching of mathematics and science in late Qing China. According to a General Affairs Office (*Zongli yamen*) memorial of May 18, 1887, which advocated modifying the civil examinations to allow candidates to be

also David Wright, *Translating Science: The Transmission of Western Chemistry into Late Imperial China, 1840–1900* (Leiden: E. J. Brill, 2000), pp. 319–25.

[50] The venues to buy issues were advertised in the journal. Compare San-pao Li, 'Letters to the Editor in John Fryer's *Chinese Scientific Magazine*, 1876–1892: An Analysis,' p. 743. See also Ferdinand Dagenais, *John Fryer's Calendar: Correspondence, Publications, and Miscellaneous Papers with Excerpts and Commentary* (Berkeley: Center for Chinese Studies, University of California, Berkeley, 1999), Version 3, 1891:1; Bennett, *John Fryer*, pp. 50–5, and David Wright, 'Careers in Western Science in Nineteenth-Century China, pp. 49–90.

examined in mathematics, the Shanghai Polytechnic was training half of the talented students of mathematics in the empire.[51]

In addition *The Chinese Scientific and Industrial Magazine* published some 317 inquiries sent in to the journal as 'Letters to the editor'. The letters and their context stressed the practical value of technology and showed less interest in pure science. About 123 letters (38.2%) showed some interest in or knowledge of scientific theories or abstract scientific models, which is a relatively high percentage for a journal more oriented to popular science or popular mechanics. The queries paralleled the technological interests of those involved in the Self-Strengthening movement. The large volume of letters to Fryer anticipated a more widespread awakening of interest in science after 1895 and paved the way for the general acceptance of Western science in China.[52]

After *The Chinese Scientific and Industrial Magazine* stopped publication in 1892, it was reprinted in 1893, 1896, and 1897. In the 1890s the first four volumes were reprinted as full sets to meet demand. The reissued books sold very well in the Chinese Scientific Book Depot after the Sino-Japanese War in 1895. Later under Xu Jianyin's general editorship in 1901–1902, the past issues of the journal were reorganized topically and edited under the title *Collectanea of Science* (*Gezhi congshu*) in Shanghai and reprinted for sale.[53]

By 1894, a program of free lectures on scientific and technological subjects in Chinese was authorized, which was based on a detailed curriculum of six fields that were presented in the Western curriculum of the Polytechnic dated December 1895: 1) mining; 2) electricity; 3) surveying; 4) construction engineering; 5) steam engines; and 6) manufacturing. In 1895, Fryer compiled a *Mathematical Problems Textbook* (*Xixue kecheng shuxue keti*) for the Polytechnic. Regular, free classes on Saturday evenings also were started in 1895.[54]

Besides their use in the increasing number of missionary schools, such translations were also institutionalized as texts within a

[51] *Guangxu chao donghua lu* (Records from within the Eastern Gate during the Guangxu reign) (Shanghai: Zhonghua shuju, 1909), 82.11a. See also Biggerstaff, 'Shanghai Polytechnic Institution and Reading Room,' pp. 148–9.

[52] San-pao Li, 'Letters to the Editor in John Fryer's *Chinese Scientific Magazine*,' pp. 730–1, 762.

[53] See Xu Jianyin, 'Fanli,' in Xu Jianyin (ed.), *Gezhi congshu* (Shanghai: Zhuji shuzhuang, 1900), pp. 1a–2b. See also Wang Yangzong, 'Gezhi huibian zhi Zhongguo bianjizhe kao,' pp. 238, 241. David Wright, 'Careers in Western Science in Nineteenth-Century China: Xu Shou and Xu Jianyin,' notes that Xu Jianyin oversaw the collection of reprints on science while he was at the Fuzhou Navy Yard in 1901.

[54] Dagenais, *John Fryer's Calendar*, 1895:13.

regional matrix of arsenals, factories, and technical schools that formed the nineteenth-century roots of the twentieth-century industrial revolution in China. Hence, we should also acknowledge the scope and scale of scientific translation and military arsenals elsewhere in China after 1860. A sampling of these empire-wide venues includes the following:[55]

Anqing Arsenal (1861), set up by Zeng Guofan.

Beijing Field Force Arsenal (1883).

Daye Iron Mine (1890), in Hubei.

Fuzhou Shipyard (1866), the base for the Southern Fleet, established by Zuo Zongtang.

Guangshou Arsenal (1874).

Hangzhou Arsenal (1885).

Hanyang Ironworks, in Hubei (1890), established by Zhang Zhidong.

Hanyang Arsenal (1892).

Hunan Arsenal (1875).

Jiangnan Arsenal (1865), set up in Shanghai by Zeng and Li Hongzhang.

Jilin Arsenal (1881).

Jinling Arsenal (1867) in Nanjing used for making breech rifles and steel.

Lanzhou Arsenal (1871).

Port Arthur Naval Station (Lüshun, 1881–82).

Shandong Arsenal (1875), used for gun purchase, making acid and gun powder.

Sichuan Arsenal (1877).

Tianjin Arsenal (1867), under Li Hongzhang used to manufacture gunpowder and acid.

Taiwan Arsenal (1885).

Weihaiwei Shipyard (1882) for the Northern Fleet.

Yunnan Arsenal (1884).

Xi'an Arsenal (1869).

Once the destruction of the Fuzhou Shipyard during the Sino-French War demonstrated the vulnerability of the Jiangnan Arsenal

[55] See Ting-yee Kuo and Kwang-Ching Liu, 'Self-Strenghtening: the pursuit of Western technology,' pp. 519–37, and Onoue Etsuzō, 'Chūgoku ni okeru kōgyō no ishoku—yōmu undō no ichi sokumen,' *Rokkōda ironshū* 5, 3 (October 1958): 67–86. Compare K. H. Kim, *Japanese Perspectives on China's Early Modernization*, pp. 3–12.

and other factories and fleets on the China coast to foreign naval blockade, Zhang Zhidong (1837–1909), then governor-general in Hubei and Hunan provinces in the middle Yangzi region, recognized the need for the Hanyang Ironworks (1890) and Hanyang Arsenal (1892) as protected inland industrial sites. Not funded until 1891–95, however, and then subject to competing interests of Li Hongzhang's Northern Fleet and the military threat from the Japanese in Korea, the Hanyang Arsenal found that its funds were inadequate for simultaneous development of the ironworks and the arsenal. This problem led to a slowdown in the arsenal, which failed to produce weapons or ordnance in time for Sino-Japanese War.

Other delays in plant building and a damaging fire in summer 1894 kept the Hanyang project from achieving success in the late nineteenth century. Zhang wrestled with the twin goals of strategic industrialization and modern military production in the midst of the emergency diversion of imperial funds and resources to deal with the Russian and Japanese threats. He chose to fund the ironworks for general development rather than the arsenal for military arms. Hence, the Hanyang Ironworks became the hub of China's iron and steel industry during the first half of the twentieth century, although it failed to contribute to the Sino-Japanese War.[56]

If we repopulate this impressive list of modern industrial venues with the human lives and literati careers they instantiated, then we can trace more clearly the post-Taiping successors to the native calendricists and mathematical astronomers that compilation of the *Biographies of Astronomers and Mathematicians* (*Chouren zhuan*) had adumbrated circa 1800.[57] Now, however, a new group of artisans, technicians, and engineers were emerging beween 1865 ad 1895 who gained an independent position from the fields of classical learning monopolized by the customary scholar-officials. Increasingly, they were no longer subordinate to the dynastic orthodoxy or its official representatives.

Still a necessary part of the cultural, political, and social hierarchies, the new students of the sciences in the arsenals and missionary schools emerged from the older categories of the myriad elite aspirants for official status as a literatus. The 'scientist' (*gewu zhe*) was

[56] Thomas Kennedy, 'Chang Chih-tung and the Struggle for Strategic Industrialization: The Establishment of the Hanyang Arsenal. 1884–1895,' *Harvard Journal of Asiatic Studies* 33 (1973): 154–82.

[57] See B. A. Elman, 'Jesuit Scientia and Natural Studies in Late Imperial China,' *Early Modern History: Contacts, Comparisons, Contrasts* 6, 3 (Fall 2002): 209–31.

'one who investigated things', and he now coexisted with the orthodox classical scholar in the bureaucratic apparatus but still at lower levels of political rank, cultural distinction, and social esteem. Meng Yue has perceptively noted that the self-taught students of modern science and technology in the 1850s, such as Xu Shou, Hua Hengfang, Xu Jianyin, and Li Shanlan, were successors of the Yangzi delta 'astronomers and mathematicians' who had emerged during the rise of mathematics in an age of evidential research.[58]

In Xu Shou's case, evidential research could also serve as preparation for mastering Western science. Xu Shou, Li Shanlan et al., were in turn succeeded by the Yan Fus and Lu Xun (Zhou Shuren, 1881–1936) who were drawn to the Fuzhou Navy Yard and the Jiangnan Arsenal for formal training in science, mathematics, and engineering. An examination scandal had affected Lu Xun's family both financially and socially, and Lu was forced to leave his lineage school. Before turning to literature, Lu Xun was first trained at the Jiangnan Arsenal, and he later traveled to Japan to study modern medicine at Sendai just before the 1904–05 Russo-Japanese War.[59]

By going outside the orthodox curriculum of the civil service examination, the newly educated in science, mathematics, and engineering inhabited the unprecedented institutional venues of arsenals, shipyards, and industrial factories that promoted non-degree-oriented engineering, mathematical, and science studies. Once put in place institutionally by the regional leaders of the diffuse Foreign Affairs Movement, technical expertise in engineering and mechanics and specialized knowledge of the modern sciences gathered momentum, albeit slowly, within what Meng Yue describes as 'an independent, hybrid, even international field of cultural production'.[60]

Eventually, thousands of administrative experts, translators, and advisors—including hundreds of foreigners—served in provincial schools and regional arsenals under the chief provincial ministers of the late Qing, Zeng, Li, Zuo, and Zhang, who were the leaders of the turn toward foreign studies focusing on science and industry. Literati

[58] Meng Yue, 'Hybrid Science,' pp. 25–8.

[59] David Wright, 'The Great Desideratum: Chinese Chemical Nomenclature and the Transmission of Western Chemical Concepts,' *Chinese Science* 14(1997): 35–70. On Lu Xun, see Howard Boorman and Richard Howard (eds), *Biographical Dictionary of Republican China* (N.Y.: Columbia University Press, 1967), p. 417.

[60] Meng Yue, 'Hybrid Science,' pp. 26–7. Compare David Wright, 'Careers in Western Science,' pp. 51–80, 88.

associated with statecraft and evidential studies after the Taiping Rebellion created the intellectual space needed to legitimate literati study of natural studies and mathematics within the framework of 'Chinese studies as fundamental, Western learning as useful' (*Zhongxue wei ti Xixue wei yong*).

The promising start made in missionary schools and the empire-wide arsenals accelerated in the 1880s when Shanghai and Beijing took the lead in promoting the new fields associated with the Foreign Studies Movement. China's defeats in the Sino-French and Sino-Japanese wars, unfortunately, produced an intellectual backlash from foreigners in China and Chinese literati that China was doomed unless more radical political initiatives were carried out. In the process, the rhetoric favoring modern science became a key aspect of the political discourses of reformers and revolutionaries.

The Impact of Science Translations in Qing China on Japan

Before 1894, Japan had imported many European books on science that had been translated in China after the Japanese expelled the Jesuits for their meddling in the sixteenth-century civil wars there. Chinese translation of Euclid's geometry and Tychonic astronomy, for example, had made their way to Tokugawa Japan (1600–1857). Both the late Ming collectanea *Works on Calendrical Studies of the Chongzhen Reign* (*Chongzhen lishu*) and the Kangxi era *Compendium of Observational and Computational Astronomy* (*Lixiang kaocheng*) arrived in Japan via the Ningbo–Nagasaki trade after the 1720s. The Japanese also avidly imported physics, chemistry, and botany books from Europe via the Dutch trading enclave in Nagasaki harbor in the early nineteenth century.[61]

In addition, the importance of nineteenth-century translations on science prepared under the auspices of Protestant missionaries in the treaty ports and others at the London Missionary Society's Inkstone Press in Shanghai was quickly recognized by the Meiji government. Prominent translations into Chinese of works dealing with symbolic algebra, calculus, Newtonian mechanics, and modern astro-

[61] See Nakamura Kyūshirō, 'Kinsei Shina no Nihon bunka ni oyoboshitaru seiryoku eikyō, *Shigaku zasshi* 25, 12 (December 1914): 1597–1605. Compare Jurgis Elisonas (George Elison), 'Christianity and the Daimyo,' in John Hall (ed.), *The Cambridge History of Japan*. Volume 4. *Early Modern Japan* (Cambridge: Cambridge University Press, 1991), pp. 301–72.

nomy quickly led to Japanese editions and Japanese translations of these works. Dr Daniel Jerome Macgowan's (1814–93) 1851 *Philosophical Almanac* (*Bowu tongshu*), for instance, had a Japanese edition, and Dr Benjamin Hobson's (1816–73) 1855 *Treatise of Natural Philsophy* (*Bowu xinbian*) from the Guangzhou Hospital came out as a Japanese edition in 1859, for instance. Four other of Hobson's medical works from 1851–58 quickly came out in Japan between 1858 and 1864.[62]

Issues from the 1850s *Shanghae Serial* (*Liuhe congtan*), which included numerous articles introducing European science, were also republished in Japan, along with the translations Fryer et al. completed in the Jiangnan Arsenal and the publications from the Beijing School of Foreign Languages. The translations of algebra (1859/1872), calculus (1859/1872), and Martin's *Natural Philosophy* (1867/1869) were all quickly available to scholars and officials in Meiji Japan. Arguably, these works had greater influence in Japan than China, and they can still be easily found in libraries there, while they are rare in China.[63]

Many Chinese scientific terms were preferred in Meiji Japan over the translations derived from Dutch Learning. The Chinese name for chemistry (*huaxue*), for example, replaced the term *chemie* [*semi* in Japanese] that was derived from Dutch. Similarly, the impact of Jiangnan Arsenal publications can be seen in the choice of Chinese terminology for metallurgy (*jinshi xue*) used in Japanese publications, which were later changed in Japan and reintroduced to China as a new term for mining (*kuangwu xue*).

When the Japanese diplomat Yanagihara Sakimitsu (1850–94) visited China several times, he purchased many of the Chinese scientific translations. On his third visit in 1872, for instance, he bought twelve titles on science and technology in 31 volumes from the Jiangnan Arsenal. These included works on chemistry, ship technology, geography, traditional mathematics, mining, and trigonometry. The Japanese government continued to buy Arsenal books until 1877. In 1874, Yanagihara received twenty-one newly trans-

[62] See Chen Liwei, 'Meiji shoki ni okeru Kan yakusho no shūyō,' *Tōhōgaku* 99 (2000): 61–74, and Wang Yangzong, '1850 niandai zhi 1910 nian Zhongguo yu Riben zhi jian kexue shuji de jiaoliu shulue,' *Tōzai gakujutsu kenkyūjo kiyō* (Kansai University) 33 (March 2000): 139–52.

[63] Wang Bing, 'Jindai zaoqi Zhongguo he Riben zhi jian de wulixue jiaoliu,' *Ziran kexueshi yanjiu* 15, 3 (1996): 227–33. See also Wang Yangzong, '1850 niandai zhi 1910 nian Zhongguo yu Riben zhi jian kexue shuji de jiaoliu shulue,' p. 140.

lated books from China. Despite the influence of Dutch learning and translations from China, the Japanese began teaching modern Western science on a large scale only in 1870s, and thus the Chinese did not borrow many scientific terms from Japan before the Sino-Japanese War.[64]

Naval Warfare and the Refraction of Qing Reforms Into Failure

Not until the Sino-Japanese War of 1894–95, when the Japanese navy, which was tied to Yokosuka military technology, decisively defeated the Qing navy, which was tied to Fuzhou and Shanghai technology, did the alleged superiority of Japan in modern science, or so it was interpreted, become common knowledge to Chinese and Japanese patriots. Although the Jiangnan Arsenal and Fuzhou Ship Yard had appeared superior in science and technology to the Yokosuka Dockyard until the 1880s, after 1895 each side read their different fates in the war teleologically back to the early Meiji period, in the case of triumphant Japan, or back to the failures of the Self-Strengthening movement after 1865, in the case of the defeated Qing.

The Jiangnan Arsenal and the Fuzhou Shipyard, for example, were generally acknowledged by contemporary Europeans and Japanese to be more advanced than their chief competitor in Meiji Japan, the Yokosuka Dockyard, until the 1880s. David Pong has contended, for instance, that had the Qing navy engaged the Japanese in a naval battle over Taiwan in 1874–75, when the Japanese threatened the island in April 1874, Chinese maritime defense preparations would have gained greater support. Due to a policy debate, however, the Chinese sued for peace to avoid hostilities with the result that the budget for the two modern naval fleets in north and south China was cut to four million taels (5.56 million silver dollars), much less than was needed. We have seen above that the mid-1870s saw a cutback in the production of ships in both the Jiangnan Arsenal and Fuzhou Shipyard. In the mid- and late 1870s China's armaments industries

[64] Nakamura Kyūshirō, 'Kinsei Shina no Nihon bunka ni oyoboshitaru seiryoku eikyō, p. 1597, and Wang Yangzong, '1850 niandai zhi 1910 nian Zhongguo yu Riben zhi jian kexue shuji de jiaoliu shulue,' p. 142. Compare David Wright, 'The Translation of Modern Western Science in Nineteenth-Century China, 1840–1895,' *Isis* 89 (1998): 671.

were mainly producing ammunition for Zuo Zongtang's army to reconquer Xinjiang in the northwest. Besides financial difficulties, corruption was also rife among leading officials who competed with each other for the remaining funds.[65]

According to Rawlinson, only three Japanese ships with about 3,600 men were in the 1874 Japanese expedition to Taiwan. The Japanese naval ministry was established in 1872, and by 1874 it had just seventeen ordinary ships with an aggregate of about 14,000 tons. Foreign observers thought China's twenty-one steamers in the one thousand ton class would be able to handle the Japanese threat, but, as in 1894–95, the Chinese ships were not organized into a unified fleet.

Since it woud take time to gather a fleet in Taiwan, and because he wrongly feared that Japan had two ironclad warships, Shen Baochen as the Director-general of the Fuzhou Navy Yard agreed to end the crisis with a financial payment to Japan and de facto recognition of Japanese control over the Liuqiu (Ryūkyū) Islands. By 1879, China had two ironclad steamships, which had been ordered from the Vulcan factory in the Baltic for the Northern Beiyang Fleet and were more advanced than anything the Japanese navy had at the time. They were both sunk in the Sino-Japanese War. In gunpowder manufacture, moreover, the machinery used in Germany, interestingly, was not as advanced as that in Shanghai at the Jiangnan Arsenal. China's naval superiority would never again be that manifest.[66]

The Impact of the Sino-French War

The lack of coordination between the northern and southern navies became the chief disadvantage of the Chinese fleets vis-à-vis their counterpart in Japan, which was a unified fleet stationed in Yokosuka under a central command. This disadvantage became clearer after

[65] See Thomas Kennedy, *The Arms of Kiangnan*, pp. 150–60, and Pong, *Shen Paochen and China's Modernization*, pp. 292–3, 335. See also Kitayama Yasuo, 'Chūgoku ni okeru kan'ei gunji kōgyō no ichi kōsatsu—Kōnan seizōkyoku o chūshin to shite,' *Hisutoria* 9 (1954): 1–8, who contends that Zeng, Li, and Zuo built up the armaments industry mainly for their power bases and to maintain domestic security, not to defend against attacks from foreign aggression.

[66] John Rawlinson, *China's Struggle for Naval Development, 1839–1895*, pp. 60–1, and David Wright, 'Careers in Western Science,' p. 81.

1874 when the French claimed Vietnam as protectorate leading to conflict with Qing China in the upper Red River area in northern Vietnam. France then began a naval buildup on the China coast which provoked several naval engagements. France did not win all the battles of the Sino-French War, but it did win the war in 1884–85 because of the lack of coordination between the vulnerable Chinese fleet based at the Fuzhou Shipyard and the Beiyang Fleet under Li Hongzhang's control in the north. The irony that a French sponsored Chinese navy yard at the Mawei anchorage in Fuzhou would be destroyed—before war had been declared—by a French flotilla using Vietnam as its base suggests the dangers of relying on European aid in an age of imperialism.

The Qing had over fifty modern naval ships in 1884, with more than half built in China. Among the others, thirteen were Armstrong gunboats, two were Armstrong cruisers, and two more were German ships with two 8″ guns each. The latter two pairs were divided equally between the northern Beiyang fleet and southern Nanyang fleet. The Qing navy, however, was divided into four fleets: the Northern at Weihaiwei and Port Arthur, one in Shanghai, another in Fuzhou, and the smallest in Guangzhou. Unfortunately, the 1884–85 war was fought by Fuzhou flotilla nearly alone in the climactic battle at its home port of Mawei.

At Mawei, the Fuzhou fleet was almost completely destroyed in fifteen minutes in part due to the vagueness of international law when war had not yet been declared. This diplomatic nicety had allowed French war vessels to sail past the Min River defenses and approach the Fuzhou dockyard unchallenged. Hence, China, unlike France, had not made preparations for war. The modern fleet at the Mawei anchorage numbered eleven ships on August 23, 1884. All were at least nine years old and made of wood. Eight French vessels were anchored near by and were on the whole superior, but the Chinese ships had respectable if non-standard armaments. Nor did the Chinese take advantage of the tides to outmaneuver the heavier French vessels. Li Hongzhang only sent two of the ships requested from his Beiyang fleet, and he withdrew these from the battle by asserting that the Japanese threat in Korea mandated their return north.

The French fleet withdrew to Taiwan, but after a failed landing there it threw a blockade around the west coast of the island. Negotiations then resumed after a Chinese land victory over the French. China's loss, then, was not simply due to French military superiority. Rawlinson has noted that French technological superiority in the

1880s was not as great as England's in the Opium War of 1839–42 and the Second China War of 1856–60. The gap between China and Europe had been closed technologically. The actual problems were: 1) the political and regional disorganization of the empire; and 2) naval personnel were insufficiently trained and had a poor grasp of modern naval strategy.[67]

In the postwar period, progress at the Fuzhou dockyard was limited in scope, while Li Hongzhang sought to purchase naval vessels for his Northern Fleet rather than build them at home. Li also had to supply his Anhui land army. After most of the Fuzhou squadron was destroyed by the French in 1884, a foreign-built ship was purchased and used as a training vessel. The Fuzhou Navy Yard also reduced its number of engineers and skilled workmen, but it continued to operate in the 1890s despite neglect. One ship each year was launched in 1891, 1892, and 1895. Books and supplies were damaged but restored by 1886.

The rise of the Beiyang fleet as China's chief fleet after 1885 was the result of the 'Disaster in the South.' Although demanded by the court, subsequent efforts to create a single command for a unified naval fleet never succeeded. The new Navy Board and Li's Beiyang fleet competed for financial resources, which were declining due to further naval budget cuts between 1885 and 1894. The Empress Dowager's efforts to garner funds for her ambitious plans to expand the Summer Palace did not use up the imperial treasury or leave nothing for the Chinese navy, but inadequate funding did set limits on Li Hongzhang's plans to expand the Northern Fleet.[68]

The apparent strength of the Beiyang fleet, however, was clear to the Japanese because of stops the Chinese fleet made there in the 1880s after cruises to Vladivostok. Moreover, the inconclusiveness of the Sino-French War, which was reported in Japan, had restored Chinese prestige in Japanese eyes from the low it had reached after the Opium War. In the 'Nagasaki Incident' of 1886, for instance, four warships of the Northern Fleet dropped anchor in Nagasaki on their return trip from the Russian port. Reinforced by new ships

[67] Rawlinson, *China's Struggle for Naval Development*, pp. 109–28. Compare Fung, 'Testing the Self-Strengthening,' pp. 1010–15, who also stresses China's lack of preparedness for the Sino-Japanese War, when the Japanese navy, like the French, attacked without warning.

[68] Rawlinson, *China's Struggle for Naval Development*, pp. 129–39, amd Biggerstaff, *The Earliest Modern Government Schools* pp. 221–2. See also Kwang-Ching Liu and Richard Smith, 'The Military Challenge,' pp. 254–6.

purchased from Germany, Li Hongzhang sought to make a propaganda statement by showing the Japanese that China's naval equipment was superior to Japan's. Fights between Chinese sailors, who claimed the right of extraterritoriality while in Japan, and Nagasaki police, who viewed it differently, broke out during the port call, and each side blamed the other.

Japanese hostility was apparently aroused by China's flaunting of its naval superiority. Similarly, the 'Kobe Incident' of 1889 was based on Japanese–Chinese fights that became a diplomatic dispute after a Chinese port stop there. Another visit by the Chinese fleet in July 1890 was reported in the newspaper *Citizen's Press* (*Kokumin shimbun*) as an instance of the Chinese showing off their new ships. Toyama Masakazu (1848–1900), an educator and former president of Tokyo University, visited the flagship of the Chinese fleet and came away impressed with its large caliber guns and thick steel armor. The Sino-Japanese War put an end to these diplomatic controversies by exploding the notion of Chinese superiority and rejecting Chinese claims of extraterritoriality in Japan.[69]

The Sino-Japanese War and Its Aftermath

Upon the unexpected outbreak of the Sino-Japanese War on July 24, 1894, the foreign press generally predicted an eventual Chinese victory, even after reports of initial Chinese losses. G. A. Ballard, Vice-Admiral in the British Royal Navy, thought the Beiyang fleet in the 1890s was in serviceable condition and ready for action. Later comparisons between the naval fleets of China and Japan indicated that China might have won the sea war. Japan's fleet totaled 32 warships and 23 torpedo boats manned by 13,928 men. Ten were built in Britain, and two in France. The Yoshino from Armstrong's shipyard was regarded as the fastest vessel of its time when it was timed at twenty-three knots in 1893 trials. China's navy still had a four-fold division into the Beiyang, Nanyang, Fujian, and Guangdong fleets, however. In

[69] Noriko Kamachi, 'The Chinese in Meiji Japan: Their Interaction with the Japanese before the Sino-Japanese War,' in Akira Iriye, (ed), *The Chinese and the Japanese: Essays in Political and Cultural Interactions* (Princeton University Press, 1980), pp. 69–72. See also Donald Keene, 'The Sino-Japanese War of 1894–95 and Its Cultural Effects in Japan,' in Donald Shively (ed), *Tradition and Modernization in Japanese Culture* (Princeton: Princeton University Press, 1971), pp. 122–3.

1894, these four combined had about 65 large ships and 43 torpedo boats. The strongest was the Beiyang fleet which more or less equaled Japan's entire fleet.[70]

If general opinion among foreigners favored Li Hongshang's fleet over Japan's, then Japanese newspapers, magazines and fiction were marked by exhilaration at the prospect of war with Qing China. Many Japanese themselves were not overly confident of victory, however. The publicist Fukuzawa Yukichi (1835–1901), warned against overconfidence, for instance, although he agreed with Japan's just cause in spreading independence and enlightenment to a Korea allegedly subjugated by China. Indeed, Japanese Diet members were surprised at the easy victory, and the Meiji emperor was reluctant to begin hostilities. He had refused to send messengers to the imperial shrines at Ise or to his father's grave to announce the war until the news of the initial Japanese victories was communicated to Tokyo.[71]

Another British observer noted, however, that on the Chinese ships engaged in the Sino-Japanese War, Chinese crews were at half-strength but salaries for full crews were paid. The greatest contrast lay in the fact, however, that Japan's navy was unified. There was some synchronization between China's four fleets, but in the end the Beiyang navy was left to fight the Japanese principally alone. Li had kept his fleet out of the Fuzhou battle in 1884, and the Nanyang officers now got their revenge on the Northern Fleet by keeping the Southern Fleet out of war with Japan for the most part. No national fleet existed, even on paper.

With the political and economic opening of Korea as the key dispute in Sino-Japanese relations, hostilities commenced when Japan seized the Korean king shortly after Li Hongzhang sent Qing troops into Korea in July 1894 to preserve Korea as a Qing tributary. The Korean king's regent then declared war on China. The first encounter between Chinese and Japanese ships occurred in late July at Fengdao, when China's two warships proved no match against an unprovoked attack by Japan's ships. After that sea battle, the Qing Northern Fleet tried to defend the Chinese coast from Weihaiwei to the mouth of Yalu River and declared war on Japan on August 1st.

[70] Rawlinson, *China's Struggle for Naval Development*, pp. 163–9. See also Keene, 'The Sino-Japanese War of 1894–95 and Its Cultural Effects in Japan,' p. 132.

[71] Keene, 'The Sino-Japanese War of 1894–95 and Its Cultural Effects in Japan,' p. 127, 132 Compare Shumpei Okamoto, 'Background of the Sino-Japanese War, 1894–95,' in *Impressions of the Front: Woodcuts of the Sino-Japanese War, 1894–95* (Philadelphia: Museum of Art, 1983), p. 13.

Subsequently, the Japanese naval raid at Weihaiwei on August 10 stunned the Qing court, while Li Hongzhang stalled and made excuses for his inadequate ships. The main Beiyang fleet gathered at the mouth of the Yalu where the great naval battle with Japan for control of the Yellow Sea commenced on September 17. Each side had twelve ships in the clash. China had the advantage in armor and weight in a single salvo, while Japan had a decided advantage in speed of ships and metal thrown in a sustained exchange of salvos. Japan had more quick-firing guns that could fire three times the weight of metal from China's 6″ to 12″ guns.[72]

Technology alone, however, was not the key determinant of the outcome. Japan proved to be superior in naval leadership, ship maneuverability, and the availability of explosive shells. Some observers described the Fuzhou-trained officers as cowards, and they were the dominant Chinese group because of their experience and training when compared to the Tianjin trained officers, few of whom were captains. In 1892, for example, most engine-room appointments still went to Fuzhou graduates. Nine of the twelve captains of the Beiyang ships that fought Japan at mouth of the Yalu were Fuzhou graduates. Cowardice was not the decisive factor, however, because China fired 197 12″ projectiles at the decisive naval battle of Yalu, with only half of them being solid shot rather than explosive shell. They scored ten hits with six shots and four shells.[73]

From smaller guns, Chinese fired 482 shots and registered 58 hits, 22 on one ship, the Hiyei. They also launched 5 torpedoes without hits. China scored about 10% of her tries. The Japanese, on the other hand, with their quick-firers scored about 15% of their tries. In addition, the Chinese were hampered by woeful shortages of ammunition especially for her ships' big guns. Some were filled through the black market with cement rather than explosives, e.g., the one that struck the Matsushima and the two that passed through the Saikyo. This suggests that there were serious corruption problems in Li Hongzhang's supply command. With hindsight, assuming the same strategic decisions, it was clear that the speed and rapidity of fire were more important at Yalu than the weight of the vessel and its armor.

Shore engagements continued after the battle at the Yalu as the Japanese took advantage of their dramatic victory at sea to launch a

[72] Rawlinson, *China's Struggle for Naval Development*, pp. 169–74, 201.
[73] Biggerstaff, 'The Earliest Modern Government Schools, p. 248.

land war, which allowed the Japanese First Army to occupy Pyongyang and then cross the Yalu to enter China at the Manchurian border. The Japanese Second Army, formed in September 1894, landed on the Liaodong Peninsula and took Port Arthur. Li Hongzhang now sought to rebuild his navy minus the Weihaiwei naval port. The poor command structure of the Beiyang Fleet and the lack of a court martial system made it impossible to place blame on officers and allocate reward properly, although many were made scapegoats for the defeat. Moreover, the Qing personnel system of naval rewards and punishments was filled with inequality and unpredictability. Many Chinese captains and officers simply committed suicide. No one dared to question the command structure or demand a board of review independent of the navy.[74]

The Sino-Japanese War generated intense Japanese self-confidence after 1895. Moreover, Japanese industrialization accelerated after the Qing dynasty was forced to pay a considerable indemnity to the Meiji regime. Korea and Taiwan were ceded to Japan as virtual colonies. Wider Western notice of the smaller island kingdom that had defeated the Chinese empire also ensued. The Japanese victory, however, had angered the Russians who feared Japanese expansion on the Asian continent. In concert with Germany and France, the Russians joined in a Triple Intervention after the Treaty of Shimonoseki was signed in April 1895, which forced the Japanese to withdraw from the strategic Liaodong Peninsula in exhange for an additional payment from the Qing government.[75]

For the Japanese public, the war victory developed into the key event that energized the newly emergent Meiji press, and drowned out editorial debate over the war. Public rage was also directed at the European powers for intervening on the side of China. When Russia later forced the Qing to lease the Liaodong Peninsula to them, the Japanese were primed for war with Moscow over China. Public enthusiasm for military adventures became a common event when the dissemination of the national news became a central fea-

[74] Rawlinson, *China's Struggle for Naval Development*, pp. 174–97. See also Yoda Yoshiie, 'Jūkyūseiki kōhan ni okeru Nisshin ryōgoku no shokusan seisaku ni tsuite', *Shakai kagaku tōkyū* 12, 3 (March 1967): 1–38. Compare Louise Virgin, 'Japan at the Dawn of the Modern Age,' in *Japan at the Dawn of the Modern Age: Woodblock Prints from the Meiji Era, 1868–1912* (Boston: Museum of Fine Arts, 2001), pp. 66–72, 86.

[75] See Shumpei Okamoto, 'Background of the Sino-Japanese War, 1894–95,' p. 16, and Virgin, 'Japan at the Dawn of the Modern Age,' p. 112.

ture of the Japanese press after 1895. There were by then 600 thousand newspaper subscribers altogether in Tokyo and Osaka alone. The Japanese victory over China echoed throughout the country and demonstrated to Japanese the preeminence of Meiji Japan in East Asia, and the Japanese naval victory over Russia in 1904–05 cemented such national exuberance.

The shift to an information press in Meiji Japan, which grew out of news accounts of the Sino-Japanese War, stimulated the demand for news and information in a new, unified Japanese language. The Hakubunkai Publishing House, for example, took advantage of the outbreak of war and quickly published a tri-monthly, illustrated record in September 1894 entitled the *Diary of the Japanese War with Qing China* (*Nisshin sensō jikki*), which was enormously popular and helped create a cult of Japanese war heroes. Other publishers quickly followed suit, and novels, plays and woodblock printed posters about the war became best-sellers. The *Yomiuri shimbun* newspaper initiated a prize competition for the 'best' anti-Chinese war songs.[76]

In a completely opposite way, the naval disaster at the Yalu River and the decisive Qing defeat in the Sino-Japanese War, energized public criticism of the dynasty's inadequate policies and enervated the staunch conservatives at court and in the provinces who had opposed Westernization. The unexpected naval disaster at the hands of Japan had shocked many literati and officials and now led to a new respect for Western studies in literati circles. The renewed success of the Shanghai Polytechnic in 1896, for example, was tied to this event. John Fryer now reported: 'The book business is advancing with rapid strides all over China, and the printers cannot keep pace with it. China is awakening at last.'[77]

Japanese Science in China After 1895

Unfortunately for Fryer and the missionaries, China increasingly imported science books that were translated or edited in Japan after

[76] See Keen, 'Sino-Japanese War of 1894–95 and Its Cultural Effects in Japan,' pp. 121–75. See also James Huffman, 'Commercialization and Changing World of the Mid-Meiji Press,' pp. 574–9, and Giles Richter, 'Entrepreneurship and Culture The Hakubunkai Publishing Empire in Meiji Japan,' p. 591, both in Helen Hardacre and Adam Kern (eds), *New Directions in the Study of Meiji Japan* (Leiden: E. J. Brill, 1992).

[77] David Wright, 'John Fryer and the Shanghai Polytechnic: making space for science in nineteenth-century China,' *British Journal of History of Science* 29 (1996): 15, and Ting-yee Kuo and Kwang-Ching Liu, 'Self-Strengthening: the pursuit of Western technology,' p. 587.

the Sino-Japanese War. Accordingly, there was a decisive sea change from missionary-based Chinese terminology for science from the 1840s to Japan-based Chinese terminology from 1900 with the Sino-Japanese War as key point of change. From 1896 to 1910, Chinese translated science books from Japan that were based on Japan's own translations because, unlike the Chinese, the Japanese no longer worked with foreigners to produce science translations. By 1905, when educational reforms were introduced as the key to the 'New Governance' policies of the Qing dynasty, the new Ministry of Education was staunchly in favor of science education and textbooks based on the Japanese scientific system. Instead of the 'West' represented by Protestant missionaries such as Martin or more secular Christians such as Fryer, Japan now became the mediator of West for Chinese literati and officials.[78]

After the Sino-Japanese War, reformers such as Kang Youwei and Zhang Zhidong encouraged Chinese students to study in Japan. Zhang's *A Plea for Learning* (*Quanxue pian*), which was presented to the throne and then distributed widely, was particularly influential in this regard. Kang promoted Meiji Japanese scholarship in his *Annotated Bibliography of Japanese Books* (*Riben shumu zhi*) and in his reform memorials to the Guangxu emperor (r. 1875–1908). Kang recommended 339 works in medicine and 380 works in the sciences (*lixue*), which now replaced Liang Qichao's missionary-based list of the best Western books on science. The Guangxu emperor's edict of 1898 encouraged study in Japan. By 1905, eight thousand Chinese were studying in Japan, and this number increased dramatically by 50% in 1906, before declining to four thousand by the end of the decade. Between 1900 and 1937, about 34,000 Chinese studied overseas in Japan.[79]

The Construction of China's 'Backwardness' after the Sino-Japanese War

The Sino-Japanese War provoked a striking switch in Protestant confidence about the future of Qing China. An account of the Chinese

[78] Wang Yangzong, '1850 niandai zhi 1910 nian Zhongguo yu Riben zhi jian kexue shuji de jiaoliu shulue, pp. 139–44. See also Tsuen-hsuin Tsien, 'Western Impact on China Through Translation,' *Far Eastern Quarterly* 13 (1954): 323–5.

[79] Wang Yangzong, '1850 niandai zhi 1910 nian Zhongguo yu Riben zhi jian kexue shuji de jiaoliu shulue,' pp. 144–5. See also *ECCP*, p. 30. Compare Douglas Reynolds, *China, 1898–1912* (Cambridge: Harvard Council on East Asian Studies, 1973), pp. 48, 58–61, and Barry Keenan, 'Beyond the Rising Sun: The Shift in the Chinese Movement to Study Abroad,' in Laurence Thompson (ed.), *Studia Asiatica* (San Francisco: Chinese Materials Center, 1975), p. 157.

defeat prepared by one of the leading Protestant missionaries and translators in Beijing, Young J. Allen, when translated into Chinese, was frequently pirated, for example, and became required reading for the 1896 Hunan provincial examination in Changsha. Allen's account of the defeat outlined his views of needed reforms in China. Earlier Allen had published an extended essay entitled 'Precis of Sino-Western Relations' (*Zhongxi guanxi luelun*) in the September 1875 to April 1876 issues of the *Review of the Times* (*Wan'guo gongbao*). The *Review*'s accounts of the war with Japan were republished in 1898 as a massive tome and immediately sold out its 3,000 copies.[80]

Such missionary assessments were no longer gradualist. In the essay, Allen traced China's backwardness to three root causes: 1) superstition (*mixin*); 2) opium (*yapian*); and 3) civil examinations (*keju*). In this series, he also stressed the importance of science as a corrective for the causes of China's backwardness. Native studies had, according to Allen, failed to grasp the universal lessons of modern science. In particular, China's assimilation of Western science was missing the importance of 'study of the principles of things' (*wuli zhi xue*), or what in the late 1890s would be called 'physics,' which by then was based on Japanese scientific texts.[81]

The Sino-Japanese War also provoked a dramatic switch in John Fryer's confidence about the future of Qing China. In a May 22, 1895 letter to President Kellogg concerning the chair of Oriental Languages position at Berkeley University, which he would be offered in July, Fryer explained that his position in China had been strengthened because of China's defeat in the war. A 'strong tide of demand for Western learning' was now evident among Chinese literati, who were 'becoming aware of their own gross ignorance of modern arts and sciences.' He added to Kellogg: 'My translations are being bought up as fast as they can be printed, and education conducted on Western principles is becoming the order of the day. It is for this tide that I have waited patiently year after year, and now that it has begun to flow it would seem almost wrong to absent myself from the country that has so long afforded me a home and for those whose enlightenment I have so long been working.'

[80] See Xiong Yuezhi, *Xixue dongjian yu wan Qing shehui* (Shanghai: Renmin chubanshe, 1994), pp. 620–3. See also Onogawa Hidemi, *Shimmatsu seiji shisō kenkyū*, pp. 52–85. Compare Natascha Vittinghoff, 'Unity Vs. Uniformity: Liang Qichao and the Invention of a "New Journalism" for China,' *Late Imperial China* 23, 1 (June 2002): 112.

[81] See the shortened version of the essay in *Wan'guo gongbao wenxuan*, edited by Qian Zhongshu and Zhu Weizheng (Beijing: Sanlian shudian, 1998), pp. 179–201.

Why, then, entertain a teaching position at Berkeley University at this promising time? Earlier in 1880 Fryer had rejected the possibility that English would become a universal language or that China would be ruled by foreign Powers. In his 1895 letter, however, Fryer explained why he now entertained accepting the Berkeley position: 'However necessary it may be for China to have the arts and sciences of the West translated into the native language and disseminated throughout the country in the first instance, it stands to reason that this will only succeed up to a point. Beyond that point no amount of translation can keep pace with the requirements of this age of progress.' The 'complete education of China' had begun through translation, Fryer quipped, but that was only a first step.

The man who had tirelessly translated several score of works on science and technology into Chinese now assumed a more strident tone. The war had proven to him and the Chinese that their efforts since 1865 had been a failure. Fryer now became a voice of doom for China's future:

> Of course this looks to the gradual decay of the Chinese language and literature, and with them the comparative uselessness of my many years of labor. Their doom seems to be inevitable, for only the fittest can survive. It may take many generations to accomplish, but sooner or later the end must come, and English be the learned language of the Empire.[82]

This intriguingly timed Darwinian perspective belied the religious message of a natural theology that Fryer and other missionaries were encoding in their earlier translations of botany and biology for the Chinese.

On the eve of his departure for California, Fryer now publicly announced a competition for 'new age novels' (*xin xiaoshuo*) in Chinese that would enhance the morals of China and eviscerate the triple evils of opium, stereotypical examination essays, and footbinding. This appeal for a new literature written in 'easy and clear language with meaningful implications and graceful style' attracted the interest of Liang Qichao and other reformers who would provide the foundations for the call for a new culture in China premised on the failure of traditional Chinese literature. The Boxer Rebellion of 1900 confirmed the fears of most missionaries such as the devoted

[82] Dagenais, *Fryer's Calendar*, 1895: 4–6. This overturns Fryer's earlier view in 1880 in his 'An Account of the Department for the Translation of Foreign Books at the Kiangnan Arsenal, Shanghai,' pp. 77–81.

William Martin: 'Let this pagan empire be partitioned among Christian powers.'[83]

If, however, we look more carefully at the total picture of the Self-Strengthening period from 1865 to 1895, the view that Qing China was irrevocably weak and backward, in contrast to a powerful and industrialized Europe and a rapidly industrializing Japan, is an artefact of the impact of the Sino-Japanese War after 1895 on international and domestic opinion. Impatient perspectives of China's efforts to westernize after 1865, unfortunately, underestimate the crucial role the missionary translation of science, the industrialization in the arsenals, and the new government schools played in the emergence of modern science and technology in late Qing China. We should deal with the nineteenth century arsenals, factories, and translation schools by also considering them as a harbinger of the Chinese industrial revolution to come and not simply as a prelude to the end of the Qing dynasty and imperial China.

[83] Dagenais, *Fryer's Calendar*, 1895:7–8, 11–12, 1896:4, and Patrick Hanan, 'The Missionary Novels of Nineteenth-Century China,' *Harvard Journal of Asiatic Studies* 60, 2 (December 2000): 440–1. See also W. A. P. Martin, *The Awakening of China* (London: Hodder and Stoughton, 1907), p. 177. For the Boxer impact, see Jonathan Spence, *To Change China: Western Advisers in China, 1620–1960* (Middlesex: Penguin Books, 1980), pp. 158–60.