Naval Warfare and the Refraction of China's Self-Strengthening Reforms into Scientific and Technological Failure, 1860-1895

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The Scope and Scale of the Foreign Affairs Movement

In the 1950s and 1960s, Western and Japanese scholarship on the post-Taiping Rebellion (1850-64) era debated the success or failure of the 1865-1900 schools and arsenals in a modernizing Qing China. American scholars such as Mary Wright contended that the imperial system and its classical ideology, which she labeled Confucian, were incompatible. The Taiwanese scholar Wang Ermin €_ º¸ ±Ó subsequently challenged Wright's claim that classical learning and modernization were incompatible. In his study of modern Chinese naval development, John Rawlinson contended that traditional institutions based on classical ideology gave the Tongzhi Restoration (1862-74) and the "Foreign Affairs Movement" (*Yangwu yundong* ¬v °È _B °Ê) its essential character and limited its achievements. Rawlinson concluded that the Qing failure to

develop a national navy yielded a number of competing provincial squadrons based on weak imperial institutions and strong regional loyalties.[1]

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 resulted in 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 Western technicians were due to semi-colonial environment of the time. Similarly, 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.[2]

In his review of the literature, 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

[1] Mary Wright, *The Last Stand of Chinese Conservatism: The T'ung-chih Restoration, 1862–1874* (Stanford, Stanford University Press, 1957), and Wang Ermin, "Rujia chuantong yu jindai Zhong-Xi sichao zhi huitong" _§ ®a ¶Ç _Î »P ªñ ¥N €€ _è «ä _é €§ ·| _P (The literati tradition and the compatibility of Chinese and Western ideas in modern times), *Xinya xueshu jikan* ·s ¨È _Ç _N ¶° ¥Z 2 (1979): 163-78. See also John Rawlinson, *China's Struggle for Naval Development, 1839-1895* (Cambridge: Harvard University Press, 1967), pp. 198-204, and Wang Ermin, *Qingji bing gongye de xingqi* _M ©u §L €u ·~ ªº ¿_ °_ (Rise of the armaments industry in the late Qing period) (Taibei: Institute of Modern History, Academia Sinica, 1972).

[2] See Thomas Kennedy, *The Arms of Kiangnan: Modernization in the Chinese Ordnance Industry, 1860-1895* (Boulder: Westview Press, 1978), pp. 150-60, and 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 1890s. See Thomas, *Foreign Intervention and China's Industrial Development, 1870-1911* (Boulder: Westview Press, 1984).

foreign trade; and 2) the *lijin* Íù ª÷ (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 was more internal weakness than outside imperialism. In his study of the successes and failures of Foreign Affairs Movement in light of Foochow Navy Yard, however, Pong at least has stressed the potential for change in this era and has avoided characterizing the *yangwu yundong* as a failure.[3]

Japanese scholars of the late Qing modernization drive such as Hatano Yoshihiro ªi _h _¥ µ_ €j have singled out the Qing bureaucratic system as the principal factor that ensured the maintenance of 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.[4]

According to Hatano, Qing officials and literati never fully understood the external crises they faced because they were schooled in the traditional ethos of the civil examination system and thus were ignorant of the outside world. To make his point, Hatano cites the Jiangnan Arsenal and Fuzhou Shipyard. 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

[3] See 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, *Late Ch'ing, 1800-1911*, part 2 (Cambridge: Cambridge University Press, 1980), 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, and Richard Smith, "The Employment of Foreign Military Talent: Chinese Tradition and Late Ch'ing Practice," *Journal of the Hong Kong Branch of the Royal Asiatic Society*, 15 (1975).
[4] See K. H. Kim, *Japanese Perspectives on China's Early Modernization: A Bibliographical Survey* (Ann Arbor: University of Michigan, Center for Chinese Studies, 1974) for a review of the literature.

Imperial Telegraph Administration were all defense oriented, but unlike the provincial arsenals they were organized on a profit-making basis and competed successfully against foreign companies.[5]

Similar to Hatano's discussion of late Qing industry, Itô Shûichi ¥ì ÃÃ ¨q €@ has contended that science and technology in late Qing China required the dethronement of the official dynastic orthodoxy and civil examination reform before they could be advanced. In Itô'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.[6]

To challenge such negative views of the imperial Chinese state in Japanese scholarship, the eminent sinologist Miyazaki Ichisada ®c±T¥«©w , had written an earlier essay to refute claims that Qing bureaucratic control had ruined most of China's early modern industrial enterprises. According to Miyazaki, it had been Li Hongzhang's §õÂE__ (1823-1901) desire to check foreign domination of shipping in China that had motivated him to sponsor the China Merchants' Steam Navigation Company in 1872. As a *guandu shangban* ©x ·_ °Ó ¿ì (officially supervised and merchant operated) 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 dol-

[5] Hatano Yoshihiro, "Chûgoku kindaishi ni kansuru mitsu no mondai – Chûgoku no kindaika wa naze okureta ka" €€ °ê ªñ ¥N ¥v ÇR Ãö Ç@ Çr €T ÇK ÇU °_ ÃD -- €€ °ê ÇU ªñ ¥N €Æ ÇV _ó ¬G Æ_ Æõ Çs ÇF Æñ (Three questions concerning modern Chinese history – Why was China's modernization late?), *Nagoya daigaku bungakubu kenkyû ronshû* _W ¥j «Î €j _Ç €å _Ç _¡ ¬ã ¨s __ ¶°, _ú ¥v 7 (1958): 29-61. See also Hatano, *Chûgoku kindai kôgyô shi no kenkyû* €€ °ê ªñ ¥N €u ·~ ¥v ÇU ¬ã ¨s (Research on the history of modern Chinese industry) (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.

[6] Itô Shûichi, "Kindai Chûgoku ni okeru kagaku gijutsu no chii – sono shisôshi teki kôsatsu" ªñ ¥N €€ °ê ÇR Æ_ Æ÷ Çr ¬ì _Ç §_ _N ÇU _a _ì – ÇD ÇU «ä ·Q ¨Ï ªº _Ò _î (The place of science and technology in modern China – an examination of its intellectual history), *Tôyô gakujutsu kenkyû* ªF ¬v _Ç _N ¬ã ¨s 5, 5-6 (1967): 65-77.

lars) in long-term, interest free government loans, the company became the largest shipping firm operating in China by 1876. Moreover, Miyazaki ironically has noted that the company declined only after 1909 when it was privatized under the industrialist Sheng Xuanhuai's _± «Å Ãh (1849-1916) personal control.[7]

Onogawa Hidemi €p _¥ €t ¨q ¬ü in his study of the *yangwu yundong* has placed it in the first phase of a broader 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 of the 1870s and 80s, such as Xue Fucheng Á§ ºÖ _¨ (1838-94), who became an administrative expert and advisor to many of the chief ministers of the late Qing, Ma Jianzhong °¨ «Ø ©_(1844-1900) , Guo Songtao _¢ ·C Âv (1818-91), and Zeng Jize ´¿ ¬ö ¿A (183-90), advanced mercantilist proposals for developing mining, railroads, and foreign trade to create the material wealth needed for military self-strengthening.

In late nineteenth century, however, Wang Tao €_ Ãü (1828-97) proposed sweeping changes in the civil examination, military, and educational systems. Others such as Ho Qi _ó ±Òand Hu Liyuan _J Â§ «®were critical of Li Hongzhang's policies in mid-1880s because of his focus on the navy rather than basic reforms in internal administration, which they regarded as more pressing. The doctrine of "self-strengthening" eventually evolved into a doctrine of reform. Onogawa's stress on the shift from science and technology to the institutional changes needed in China in terms of government organization in the 1880s suggests that the technical achievements

[7] Miyazaki Ichisada, "Shôshô kyoku no ryakushi – Chûgoku no dokusenteki kisen kaisha" ©Û °Ó §_ ÇU _€ ¥v -- €€ °ê ÇU ¿W _û ªº ¨T _î ·| ªÀ (A Short history of the China Merchants' Company – China's Monopolistic Steamship Company), *Tôyôshi kenkyû* ªF ¬v ¥v ¬ã ¨s 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*, Volume 11, *Late Ch'ing, 1800-1911*, Part 2 (Cambridge: Cambridge University Press, 1980), pp. 422-29.

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.[8]

The Role of Arsenals in the Self-Strengthening Movement

In the summer of 1865, Li Hongzhang as Jiangsu governor and Ding Richang €B€é©÷(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* ¬v ¬¶ §_). Additional machinery was imported, and subsequently the Jiangnan Machine Manufacturing General Bureau (*Jiangnan jiqi zhizao zongju* _¿ «n _÷ __ ¨î _y Á` §_), 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 À_ Ä_ ®É (b. 1821) was appointed 1866-68. The Arsenal was moved to just outside the Chinese city of 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."[9]

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[8] Onogawa Hidemi, *Shimmatsu seiji shisô kenkyû* _M ¥_ ¬F ªv «ä ·Q ¬ã ¨s (Research on late Qing political thought) (Tokyo: Misuzu shobô, 1969), pp. 8-51, 52-85.

[9] *Jiangnan zhizaoju ji* _¿ «n »s _y §_ °O (Records of the Jiangnan Arsenal), compiled by Wei Xiangong ÃQ €_ ®¥ (1904. Reprint, Taibei: Wenhai chubanshe). See also Quan Hansheng ¥_ º~ ª@, "Qingji de Jiangnan zhizaoju" _M ©u ªº _¿ «n »s _y §_ (The Qing period Jiangnan Arsenal), *Bulletin of the Institute of History and Philology, Academia Sinica* 23 (1951): 145-59, and Wright, *The Last Stand of Chinese Conservatism: The T'ung-chih Restoration, 1862–1874* (Stanford, Stanford University Press, 1957), pp. 211-12.

In her revisionist account of the Jiangnan Arsenal, Meng Yue has described how for Zeng Guofan ´¿ °ê Ã¿(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 such a 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 Western monopoly of warships and cannons and master contemporary useful knowledge.[10]

Technical work at the arsenal was left in 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 rate of eighteen per month and used as munitions in the Nien Rebellion of the 1860s. In 1871 the arsenal finally produced breech-loading rifles of the Remington type. By 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.[11]

[10] Meng Yue, "Hybrid Science *versus* Modernity: The Practice of the Jiangnan Arsenal," *East Asian Science, Technology, and Medicine* 16 (1999): 13-52.

[11] See Thomas Kennedy, "The Establishment and Development of the Kiangnan Arsenal, 1860-95" (Columbia University Ph.D. dissertation in History, 1968), chapter 2, and Arthur Hummel, ed. *Eminent Chinese of the Ch'ing Period* (Reprint. Taibei: Chengwen Bookstore, 1972), pp. 721-22. See also Knight Biggerstaff, *The Earliest Modern Government Schools in China* (Ithaca: Cornell University Press, 1961), pp. 165-66, 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 English missionary John Fryer (1839-1928) joined it, the translation project for the Jiangnan Arsenal was initially 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 seen as too elementary and perhaps too traditional, i.e., a mimicking of the Ming-Qing encyclopedia (*leishu* Ã_®Ñ) tradition. Instead, the Translation Bureau began producing a series of industrial treatises focusing on technology and machinery, rather than mathematics and the natural sciences, with the core group of Chinese and Western translators that had been hired.[12]

From 1863, when the Imperial Court had approved creation of the Shanghai School of Foreign Languages (*Tongwen'guan* _P €åÀ], lit., "School of translated learning"), it had remained an independent school of translation. In 1869, however, the Tongwen'guan was moved within the Jiangnan Arsenal and was renamed the "School for the Diffusion of Languages" (*Guangfangyan guan* _s€è¨¥ À]). Its new buildings were paid for by the Shanghai Maritime Customs. Fryer's work was now defined to translate Western books on manufacturing as Chinese textbooks for the new school, which would include the fields of engineering, navigation, military technology, and naval affairs.[13]

Classical learning was continued in the Jiangnan Arsenal after the Shanghai Tongwen'guan moved into the Arsenal. It remained separate from the Translation Department in the

[12] Fryer, "An Account of the Department for the Translation of Foreign Books at the Kiangnan Arsenal, Shanghai," *North-China Herald*, January 29, 1880, pp. 78-79. Adrian Bennett, *John Fryer: The Introduction of Western Science and Technology into Nineteenth-Century China* (Cambridge: Harvard University Research Center, 1967), pp. 34-35, notes that after 1880, Fryer placed a greater concentration on natural sciences rather than technology.
[13] Meng Yue, "Hybrid Science *versus* Modernity: The Practice of the Jiangnan Arsenal," pp. 32-33. See also Biggerstaff, *The Earliest Modern Government Schools in China*, pp. 166-67, 173, and Bennett, *John Fryer*, pp. 18-25. Curiously, the *Guangfangyan guan* staff avoided use of 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," *North-China Herald*, January 29, 1880, pp. 81.

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 Computational Canons," several of which had been reconstituted by Qing scholars in the eighteenth century, were used to teach traditional Chinese mathematics.

Students studied Western algebra, geometry, trigonometry, astronomy, and mechanics in the lower division curriculum. They were also provided training 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 exams in Beijing.[14]

At its highest stage of development, the Jiangnan Arsenal contained four institutions: 1) Translation department; 2) School for training translators and linguists; 3) 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.[15]

[14] Biggerstaff, *The Earliest Modern Government Schools in China*, pp. 166-71. See also Jean-Claude Martzloff, *A History of Chinese Mathematics*, translated by Stephen Wilson (New York: Springer-Verlag, 1997), pp. 225-32.
[15] *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 in China*, p. 172.

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 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 technology at the Jiangnan Arsenal was actually higher than that in the leading Japanese dockyard.

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 also were by and large superior to that of Japan.[16]

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 replaced the outmoded single or double-screw engines in Chinese vessels, which China did not begin to build until 1877. An earlier proposal was turned down because of the lack of funds. Hence, China's ships were

[16] *Jiangnan zhizaoju ji*, pp. 319–28, and Meng Yue, pp. 16-24, especially Tables 1 and 2. The latter usefully summarizes Hansgeorg Jentschura, Dieter Jung, and Peter Michel, W*arships 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.

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, by the 1890s Chinese ships were still outmoded because Chinese training could not keep pace with Western technological progress.[17]

Shipbuilding in the Jiangnan Arsenal dramatically slowed after 1876. In 1885, after the Arsenal completed its first steel gunboat, it ceased to be a military shipyard. The technological switch toward steel and armored warships in Europe highlighted the difficulty of transporting iron and coal from inland provinces to make steel in coastal China. 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.[18]

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 ini-

[17] Meng Yue, p. 17. See also David Pong, *Shen Pao-chen and China's Modernization in the Nineteenth Century* (Cambridge: Cambridge University Press, 1994), p. 224, and Biggerstaff, *The Earliest Modern Government Schools in China*, pp. 246-47.
[18] Meng Yue, pp. 17-19.

tially 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, and which were capable of firing projectiles from 80 to 800 lbs. The Arsenal also became known after 1890 for its success in producing the rapid-firing machine gun, which was 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 finished 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 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.[19]

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 submitted his 1866 memorial to establish a complete 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

[19] Meng Yue, pp. 21-23. See also *Jiangnan zhizaoju ji*, pp. 374-88, 442, and Wright, "Careers in Western Science in Nineteenth-Century China," p. 80.

return, those provinces would receive naval protection from the "Southern Fleet" based at Fuzhou.

From the start, Zuo and his successor Shen Baozhen ¨H ¸¶ ·© (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.[20]

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 150 horsepower transports cost over 161 thousand taels (224 thousand silver dollars) each; five of the 80 horsepower

[20] Biggerstaff, *The Earliest Modern Government Schools*, pp. 200-08, and Pong, *Shen Pao-chen*, pp. 208-09.

ships cost over 106 thousand taels (147 thousand silver dollars), with the Yangwu corvette alone requiring 254 thousand taels (353 thousand silver dollars).[21]

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) allotted to Fuzhou over five years. Actual 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 when the Fuzhou naval fleet faced the French flotilla alone and unaided in 1884.[22]

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 built 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.[23]

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[21] Zhang Yufa ±i ¥É ªk , "Fuzhou chuanchang zhi kaichuang ji qi chuqi fazhan" ºÖ _{ _î _t €§ ¶} __ €Î ¨ä ªì ´Á µo ®i (The founding and early development of the Fuzhou Navy Yard), *Jindaishi yanjiusuo jikan* ªñ ¥N ¥v ¬ã ¨s ©Ò ©u ¥Z (Taiwan) 2 (June 1971): 177-225.

[22] David Pong, *Shen Pao-chen and China's Modernization*, pp. 241-43, 261.

[23] 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-Strengthening Movement* (Berkeley: University of California Press, 1985), Pong, *Shen Pao-chen*, pp. 214-25, and Biggerstaff, *The Earliest Modern Government Schools*, pp. 203-10.

Zuo Zongtang had also suggested opening a school for technical training called the Hall for the Search for Truth (*Qiushi tang* ¨D¬O°ó), a research slogan of Qing classicists. The school that was established was called the School for Naval Administration. Foreigners would teach English, French, mathematics, and drafting. At the same time, students were expected to master the Sacred Edict of the Kangxi emperor, just like candidates for the local civil examinations, and the Classic of Filial Piety. 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 that included 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.[24]

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*.

[24] Biggerstaff, *The Earliest Modern Government Schools in China*, pp. 203-11. See also Elman, *A Cultural History of Civil Examinations in Late Imperial China* (Berkeley: Unversity of California Press, 2000), pp. 135, 221-22.

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 Giquel's departure. The yard also faced a curtailment of operating funds due to the decline of interest by Beijing and provincial officials.[25]

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 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

[25] Biggerstaff, *The Earliest Modern Government Schools in China*, pp. 214-19.

and torpedoes. A third group of thirty-three graduates were sent in 1886, with ten from the English division, fourteen the 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 ÄY ´_ (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 the Zongli yamen still wished to send the best naval students to Europe for advanced training. 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.[26]

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 totaled 5.35 million taels (7.4 million silver dollars) for the 6.5 years to July 1874. This amount significantly

[26] See Wang Xinzhong €_ «H ©_, "Fuzhou chuanchang zhi yange" ºÖ _{ _î _t €§ ªu __ (Reform of the Fuzhou Navy Yard), *Qinghua xuebao* _M µØ _Ç _ø 8 (December 1932): 27-30, and Biggerstaff, *The Earliest Modern Government Schools in China*, pp. 223-41. See also Ting-yee Kuo and Kwang-Ching Liu, "Self-Strengthening: the pursuit of Western technology," pp. 524-25.

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. The schools and naval yard were less active in 1890s.[27]

Western Science in Translation

In 1867, a Translation Department was initiated at the Jiangnan Arsenal by Xu Shou ®} _Ø (1818-82), Hua Hengfang µØ ôÁ ªÚ (1833-1902), and Xu Jianyin ®} «Ø ±G (1845-1902), which Zeng Guofan had enlarged in 1868 to include a school to train translators. In addition to relying on foreign manufacture, Zeng and Li Hongzhang saw translation as foundation for learning the techniques of modern manufacture and the mathematics on which it was based. Their precedent was of course the late Ming and early Qing translation projects that had enabled

[27] 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 imperial calendar to be successfully reformed based on new techniques and models introduced by the Jesuits and used in the Astro-Calendric Bureau.[28]

John Fryer wrote in 1880, for instance, that the Jiangnan Arsenal had commenced publishing translations of Western works in 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.

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 by Kreyer in 1872 sold 904 copies in eight years. Another work on coast defense published in 1871 sold 1,114 copies in nine years. *A Treatise on Practical Geometry* (1871) sold 1,000 copies in eight years; *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, but even for the latter venues such numbers were disappointing.[29]

Nevertheless, the controversial reformer cum New Text classicist Kang Youwei ±d __ ¬° (1858-1927) purchased all the Arsenal works when he was in Shanghai in 1882. Between 1890 and 1892, his disciple Liang Qichao ±ç ±Ò ¶W (1873-1929) purchased many of the Arsenal's translations and the *Gezhi huibian* ®æ _P ·J _s, (lit., "Compendium for the investigation of things and the extension of knowledge") science journal. Liang developed an influential reading list based on these materials known as the "Bibliography of Western Learning" (*Xixue shumu*

[28] Masini, *The Formation of Modern Chinese Lexicon and Its Evolution Toward a National Language,* pp. 62-71.
[29] 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.

biao _è _Ç ®Ñ ¥Ø ªí), which was revised and published in 1896. Of these 329 published works, 119 (36%) were translated by Fryer. Tan Sitong ÃÓ ¶à _P (1865-98) wrote in 1894 on scientific topics and mentioned the *Gezhi huibian* as one of his sources of scientific learning. Tan had visited Fryer in Shanghai in 1893 and bought many of the Arsenal's works.[30]

Besides their use in the increasing number of missionary schools, such studies were also institutionalized as texts within a 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:[31]

- 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.
- Guangzhou 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.

[30] Bennett, *John Fryer*, pp. 42-44.

[31] See Ting-yee Kuo and Kwang-Ching Liu, "Self-Strengthening: the pursuit of Western technology," pp. 519-37, and Onoue Etsuzô §À €W ®® €T , "Chûgoku ni okeru kôgyô no ishoku – yômu undô no ichi sokumen" €€ °ê ÇR Æ_ Æ÷ Çr ªñ ¥N €u ·~ ÇU __ ´Ó -- ¬v °È _B °Ê ÇU €@ °_ _± (Transplanting modern industry to China – An aspect of the Western affairs movement), *Rokkôdaironshû* €» ¥Ò ¥x __ ¶° 5, 3 (October 1958): 67-86. Compare K. H. Kim, *Japanese Perspectives on China's Early Modernization*, pp. 3-12.

- Jilin Arsenal (1881).
- Jinling Arsenal (1867) in Nanjing used for making breech rifles and steel.
- Lanzhou Arsenal (1871).
- Shandong Arsenal (1875), used for gun purchase, making acid and gun powder.
- Sichuan Arsenal (1877).
- Tianjin Arsenal (1867), under Li Hongzhang used as gunpowder factory and to manufacture acid.
- Taiwan Arsenal (1885).
- Weihaiwei Shipyard (1882), the base for the Beiyang Fleet in "Port Arthur."
- Yunnan Arsenal (1884)
- Xian Arsenal (1869).

Once the destruction of the Fuzhou Shipyard during the Sino-French War demonstrated the vulnerability of the Jiangnan Arsenal and other factories and fleets on the China coast to foreign naval blockade, Zhang Zhidong ±i€§¬} (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 lead to a slowdown in the arsenal, which failed to produce weapons or ordinance 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.[32]

Naval Warfare and the Refraction of Qing Reforms Into Failure

It was 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, that the alleged superiority of Japan in modern science, or so it was interpreted, became 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 then read their different fates in 1895 teleologically back to the early Meiji period (later even back further to *Rangaku* Äõ _Ç "Dutch Learning" in Tokugawa Japan), in the case of triumphant Japan, or back to the failures of the self-strengthening movement after 1865 (later back to all classical learning), 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

[32] Thomas Kennedy, "Chang Chih-tung and the Struggle for Strategic Industrialization: The Establishment of the Hanyang Arsenal, 1884-1895," HJAS 33 (1973): 154-82.

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. By the late 1870s China's armaments industries were mainly producing ammunition. Besides financial difficulties, corruption was also rife among leading officials who competed with each other for the remaining funds.[33]

According to John 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 would 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 (Ryûkyû) 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

[33] See Thomas Kennedy, *The Arms of Kiangnan: Modernization in the Chinese Ordnance Industry*, pp. 150-60, and David Pong, *Shen Pao-chen and China's Modernization in the Nineteenth Century*, pp. 292-93, 335. See also Kitayama Yasuo ¥_ €s ±d €Ò , "Chûgoku ni okeru kan'ei gunji kôgyô no ichi kôsatsu – Kônan seizôkyoku o chûshin to shite" €€ °ê ÇR Æ_ Æ÷ Çr ©x Àç _x ¨Æ €u ·~ ÇU €@ _Ò _î -- _¿ «n »s _y §_ Çy €€ €ß ÇO Æ_ ÇM (Study of the government operated armaments industry – with focus on the Jiangnan Arsenal), *Hisutoria* ÇÎ Çµ ÇÄ Çæ Ç| 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.

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.[34]

The Impact of the Sino-French War

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

[34] John Rawlinson, *China's Struggle for Naval Development, 1839-1895*, pp. 60-61, and David Wright, "Careers in Western Science in Nineteenth-Century China," p. 81.

1884-85 war was fought by Fuzhou flotilla nearly alone in the climatic 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. The modern fleet at the Mawei anchorage on August 23, 1884, numbered eleven ships. 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, which suggests that on the day of the battle the Fuzhou captains were of questionable fitness. 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 had 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.[35]

In the postwar period, progress at the Fuzhou dockyard was limited in scope, while Li sought to purchase naval vessels for his Northern Fleet rather than build them at home. Li also

[35] Rawlinson, *China's Struggle for Naval Development,* pp. 109-28.

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 1885-94.[36]

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 watchfully 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 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

[36] Rawlinson, *China's Struggle for Naval Development*, pp. 129-39, and Biggerstaff, *The Earliest Modern Government Schools in China*, pp. 221-22.

was reported in the newspaper *Kokumin shimbun* °ê ¥Á ·s »D (Citizen's press) as an instance of the Chinese showing off their new ships. Toyama Masakazu ¥~ €s ¥¿ €@ (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.[37]

The Sino-Japanese War and Its Aftermath

Upon the 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 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.[38]

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[37] 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: 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), p. 122-23.

[38] Rawlinson, *China's Struggle for Naval Development*, pp. 163-69. See also Donald Keene, "The Sino-Japanese War of 1894-95 and Its Cultural Effects in Japan," p. 132.

If general opinion among foreigners favored Li Hongzhang'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 ºÖ ¿A ¿Ù _N (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.[39]

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 their 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 dynasty tributary ally. The Korean king's regent then declared war on China. The first encounter between Chinese and Japanese ships occurred on July 24th, when China's two warships proved no match against Japan's ships at Fengdao. 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.

Subsequently, the Japanese naval raid at Weihaiwei on August 10th stunned the Qing court, while Li Hongzhang stalled and made excuses for his inadequate ships. The main Beiyang

[39] Keene, "The Sino-Japanese War of 1894-95 and Its Cultural Effects in Japan," pp. 127, 132.

fleet gathered at the mouth of the Yalu where the great naval battle with Japan commenced on September 17, 1894. Each side had twelve ships in the clash. China had the advantage in armor and weight in a single salvo, while Japan had an 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.[40]

Technology was not the key determinant of the outcome, according to Rawlinson. 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. Rawlinson, however, has contended that cowardice was not the decisive factor. He has noted that China fired 197 12" projectiles at the decisive naval battle of Yalu, with half of them being solid shot rather than explosive shell. They scored ten hits with six shots and four shells.[41]

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 with cement, e.g., the one that struck the Matsushima and the two that passed through the Saikyo. This suggests to Rawlinson that there were serious corruption problems in Li Hongzhang's supply command. With hindsight, assuming the same strategic decisions, it was

[40] Rawlinson, *China's Struggle for Naval Development*, pp. 169-74, 201.
[41] Biggerstaff, The Earliest Modern Government Schools in China, p. 248.

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 decisive victory at sea. Li Hongzhang now sought to rebuild his navy minus the Weihai-wei 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 inequity and unpredictability. Many Chinese captains and officers simply committed suicide. No one dared to question the command structure or demand of the Manchu emperor a board of review independent of the navy.[42]

The Sino-Japanese War generated intense Japanese self-confidence after 1895. Moreover, Japanese industrialization accelerated after the Qing dynasty was forced to pay a sizable indemnity to the Meiji regime. Wider Western notice of the smaller island kingdom that had defeated the Chinese empire also came with the victory. 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 enthusiasm for military adventures became a common feature when the dissemination of the national news became a central feature 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.

[42] Rawlinson, *China's Struggle for Naval Development*, pp. 174-97. See also Yoda Yoshiie ¨Ì ¥_ ¿Q ®a , "Jûkyûseiki kôhan ni okeru Nisshin ryôgoku no shokusan seisaku ni tsuite" €Q €E ¥@ ¬ö «á ¥b ÇR Æ_ Æ÷ Çr €é _M ¨â °ê ÇU ´_ _£ ¬F µ_ (Concerning industrial development policies of Japan and the Qing in the second half of the nineteenth century), *Shakai kagaku tôkyû* ªÀ ·| ¬ì _Ç °Q ¨s 12, 3 (March 1967): 1-38.

The shift to an information press in Meiji Japan that 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 ¥Õ €å ·| Publishing House, for example, took advantage of the outbreak of war and quickly published a tri-monthly, illustrated record in September 1894 entitled the *Nisshin sensô jikki* €é _M _Ô ª§ €é °O (Diary of the Japanese war with Qing China), 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* Åª _æ ·s »D newspaper initiated a prize competition for the "best" anti-Chinese war songs.[43]

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/*Gezhi shuyuan* 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."[44]

[43] See Donald Keene, "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. 574-79, and Giles Richter, "Entrepreneurship and Culture The Hakubunkai Publishing Empire in Meiji Japan," pp. p. 591, both in Helen Hardacre and Adam Kern, eds., *New Directions in the Study of Meiji Japan* (Leiden: E. J. Brill, 1992).
[44] Wright, "John Fryer and the Shanghai Polytechnic," p. 15, and Ting-yee Kuo and Kwang-Ching Liu, "Self-Strengthening: the pursuit of Western technology," p. 587.

Such missionary optimism was no longer reformist, however. The account of the Sino-Japanese War prepared by one of the leading Beijing missionaries and translators, Young J. Allen, when rendered 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 also outlined his views of needed reforms in China. Earlier Allen had published an extended essay entitled "Zhongxi guanxi luelun" €€ _è Ãö «Y _€ __(Precis of Sino-Western relations) in the September 1875 to April 1876 issues of the *Wan'guo gongbao* ¸U °ê €_ _ø (Review of the Times; originally called the *Chinese Missionary News* or *Jiaohui xinbao* ±_ ·| ·s _ø in 1868). With Allen as editor, the *Wan'guo gongbao* was published weekly in Beijing from 1874 and monthly after 1889.[45]

In the essay, Allen had traced China's backwardness to three root causes: 1) superstition (*mixin* °g «H) ; 2) opium (*yapian* _~ €ù) ; and 3) civil examinations (*keju* ¬ì Á|). 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* ª« _z €§ _Ç), or what in the late 1890s would be called "physics," which by then was based on Japanese translations of Western scientific texts.[46]

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

[45] See Xiong Yuezhi ºµ €ë €§, *Xixue dongjian yu wan Qing shehui* _è _Ç ªF º¥ »P ±ß _M ªÀ ·| (The eastern dissemination of Western learning and late Qing society) (Shanghai: Renmin chubanshe, 1994), pp. 620-23. See also Onogawa Hidemi, *Shimmatsu seiji shisô kenkyû*, pp. 52-85, which stresses the shift from science and technology to institutional changes needed in Qing China for government reorganization.

[46] See the shortened version of the essay in *Wan'guo gongbao wenxuan* ¸U °ê €_ _ø €å ¿ï (Selections from the Review of the Times), edited by Qian Zhongshu ¿ú Áé ®Ñ and Zhu Weizheng _¶ ºû ¿_ (Beijing: Sanlian shudian, 1998), pp. 179-201.

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 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."

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.[47]

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 that I ill discuss elsewhere.

On the eve of his departure for California, Fryer now publicly announced a competition for "new age novels" (*xin xiaoshuo* ·s €p »¡) 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 ±ç ±Ò ¶W (1873-1929) and other reformers who would provide the foundations for the call for a new culture in China, which was premised on the failure of traditional Chinese civilization. The Boxer Rebellion of 1900 confirmed the fears of most missionaries such as the devoted William Martin: "Let this pagan empire be partitioned among Christian powers."[48]

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 artifact 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

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[47] Dagenais, *John 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," *North-China Herald*, January 29, 1880, pp. 77-81

[48] 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): 440-41. See also W. A. P. Martin, *The Awakening of China* (London: Hodder and Stoughton, 1907), p. 177. For the Boxer impact, see Jonathon Spence, *To Change China: Western Advisers in China, 1620-1960* (Middlesex: Penguin Books, 1980), pp. 158-60. David Wright, "The Translation of Modern Western Science in Nineteenth-Century China, 1840-1895," *Isis* 89 (1998): 672, contends: "The transmission of science via translations between 1840 and 1895 was a failure."

the missionary translations 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 things to come and not simply as a prelude to the end of the Qing dynasty and imperial China.[49]

[49] See Elman, *A Short Cultural History of Modern Science in Late Imperial China* (Cambridge: Harvard University Press), chapters 7 and 8, forthcoming in the Themes in the History of Science, Medicine, and Technology Series.